

LEARNED
TREATISE
OF
Globes:

Both Coelestiall and Ter-
restriall: with their severall uses.

Written first in Latine, by
Mr. Robert Hues: and by him
so Published.

Afterward Illustrated with notes, by
Isa: PONTANUS.

And now lastly made English, for the
benefit of the unlearned.

By John Chilmead Mr of A. of Christ-
Church in Oxon.

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THE
STREET

CLIPPER

Both Colwell and T
referred to with great favor

My friend Mr. H. in London
and by him
to be published.


Afterwards the same notes by
the same

And a new edition of the same
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To the Reader.

 Hat nothing is at once brought forth, and perfected, is an observation we may make, as from other things so in a more especial manner from Arts and Sciences. For (not to speak any thing of the rest, which yet have all of them in succession of times, had their accessions of Perfection) if wee but take the Astronomical writings of Aratus, or of Eudoxus, (according to whose observations Aratus is reported by Leontius Mechanicus to have composed his Phænomena) and compare the same with the later writings of Ptolomy; what errors and imperfections shall we meet withall; And in the Geographical works of the ancients, whether we compare them among themselves, the later with the former; or either of them with the more accurate descriptions of our Modern Geographers: how many things shall we meet withall herein, that need either to be corrected or erroneous, or else

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supplied as defective? There shall wee find Strabo, everywhere harshly censuring the extravagances of Eratosthenes, Hipparchus, Polybius, and Posidonius; Authors among the Ancients of very high esteem. For as for Pytheas, Euthemeres, Antiphanes, & those Indian Historiographers, Megasthenes, Nearchus, and Daimachus, whose writings are stuffed with so many fabulous idle relations, he accounts them unworthy his censure. In like manner, Marinus Tyrius, however a most diligent Writer, is yet hardly dealt withall by Ptolomy. And even Ptolomy himself, a man, that for his great knowledge and experience may seeme to have excelled all those that went before him: yet if a man shall but compare his Geographical Tables with the more perfect discoveries of our later times: what defects & imperfections shall he there discover? Who sees not his errors in the bounds he sets to the Southern parts of Asia & Africa? How imperfect are his descriptions of the Northernne coastes of Europe? These errors of Ptolomy, and of the Ancient Geographers have now, at length, been discovered by the late Sea Voyages of the Portugals, and English: the Southern Coastis of Africa and
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Asia, having been most diligently searched into by the Portugals; as the Northerne parts of Europe, have in like manner been by our owne Country-men. Among whom, the first that adventured on the discovery of these parts, were, Sir Hugh Willoughby, and Richard Chancellor: after them, Stephen Borough. And farther yet, than either of these, did Arthur Pet, and Charles Jackman discover these parts. And these voyages, were all undertaken, by the instigation of Sebastian Cabot: that so, if it were possible, there might bee found out a nearer passage to Cathay and China: yet all in vaine, save only that by this meanes, a course of traffick was confirmed betwixt us and the Moscovite.

When their attempts succeeded not this way, their next designe was then to try, what might be done on the Northerne Coasts of America: and the first undertaker of these voyages was Mr. Martin Frobisher: who was afterwards seconded by M. John Davis. By meanes of all which Navigations, many errorrs of the Ancients, and their great ignorance was discovered.

But now that all these their endeavours succeeded not, our Kingdome at that time

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being well furnished, in ships, and impatient of idleness: they resolved at length to adventure upon other parts. And first Sir Humphrey Gilbert, with great courage & Forces attempted to make a discovery of those parts of America, which were yet unknown to the Spaniard: but the successe was not answerable. Which attempt of his, was afterward more prosperously prosecuted, by that honorable Gentleman, Sir Walter Rawleigh: by whose meanes Virginia, was first discovered unto us, the Generall of his Forces being Sir Richard Greenville: which Countrey was afterwards very exactly surveighed and described by M. Thomas Harriot.

Neither have our Country-men within these limits bounded their Navigations For Sir Francis Drake, passing through the Straites of Megellane, and bearing up along the Westerne Coasts of America, discovered as far as 50. degrees of Northern Latitude. After whom, Mr. Thomas Candish, tracing the same steps, hath purchased himself as large a monument of his fame, with all succeeding ages. I shall not need to reckon with these, our Countryman, Sir John Mandivel, who almost 300. years since, in a 33. yeares V oyage by land, took a strict view

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view of all India, China, Tartary, and Persia, within the Regions adjoyning.

By these, & the like expeditions by Sea, the matter is brought to that pass, that our English Nation may seem to contend, even with the Spaniard, and Portugall himself, for the glory of Navigation. And without all doubt, had they but taken along with them, a very reasonable competency of skill in Geometry, and Astronomy: they had by this, gotten themselves a farr more honourable name at Sea, then they. And indeed, it is the opinion of many understanding men, that their endeavours have taken the lesse effect, meerely through ignorance in these Sciences. That therefore there might be some small accrrwment to their study and paines, that take delight in these Arts; I have composed this smal Treatise: which, that it may be for their profit, I earnestly desire. Farewell.

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**The Contents of the Chapters, of
this TREATISE.**

THe Preface: wherein is shewed the Antiquity, and excellency of *Globes*, in comparison of all other Instruments, as being of a forme, most apt to expresse the figure of the Heavens and Earth. The roundnes of the Earth, is defended against *Patricius*. The height of Hills, how much it may detract from the roundnesse of the Earth.

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both

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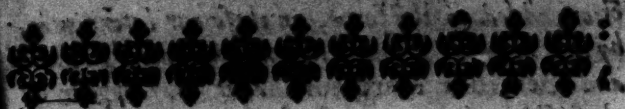
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Here are two kinds of Instruments, by which Artificers have conceived, that the figure of this so beautiful, and various fabrick of the whole Universe, might most aptly bee expressed, and, as it were, at once presented to the view. The one, exhibiting this Idea in a round solid, is called a Globe, or Sphere: The other, expressing the same in a plaine, they bearme a Planisphere, or Map; Both of which, having been long since invented by the Ancients, have yet even to our times, in a continued succession, received still more ripenesse and perfection. The Sphere or Globe, and the use thereof, is reported by Diodorus Siculus to have been first found out by Atlas of Libya: whence afterward sprang the Fable, of his bearing up the Heavens with his shoulders. Others attribute the invention of the same to Thales. And it was afterward brought to perfection by Crates, (of whom Strabo makes mention) Archimedes, and Proclus; but most of all, by Ptolomy; according to whose rules, and observations especially, succeeding times composed their Globes, as Leontius Mechanicus affirms. And now there hath been much perfe-

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tion added to the same, in these our later times, by the industry, and diligence Gemma Frisius, and Gerardus Mercator; and it may appear by those Globes, that were set forth at London, Anno 1593. so that now there seems not to bee any thing that may be added to them. The Planisphere indeed is a fine invention, and hath in it wonderful variety of workmanship, if so bee, that the composition of it be rightly deduced out of Geometricall, and Opticall principles: and it wanteth not it's great delightfullnesse, and beauty also. But that Other, being the more ancient, hath also the priority in Nature, and is of the most convenient forme; and therefore more aptly accommodated for the understanding and fancy, (not to speak any thing of the beauty, and gracefullnesse of it) for it representeth the things themselves, in proper genuine figures. For as concerning the figure of the Heavens, whether it were round, was scarcely ever questioned by any. So likewise, touching the figure of the Earth, notwithstanding many, and sundry opinions have been broached among the ancient Philosophers, some of them contending for a plain, others an hollow, others a Cubicall, and some a Pyramidall forme: yet this opinion of it's Roundnesse, with greatest consent of reason, at length prevailed, the rest being all exploded. Now wee as firme it to be round, yet so, as that wee also admit of it's inequalities, by reason of those so great eminences of hills, and depression of vallies. Eratosthenes, as hee is cited by Strabo in his first book, saith, that the fashion of the Earth is like that of a Globe, not so exactly round as an artificerall Globe

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is, but that it hath certain inequalities. The earth cannot be said to be of an exact orbicular forme, by reason of so many high hills, and low plaines: as Pliny rightly observes. And Strabo also in his first book of his Geography, saith, that the Earth and the water together, make up one sphericall body, not of so exact a forme, as that of the Heavens, although not much unlike it. This assertion of the roundnesse of the Earth, with the intervening Sea, is confirmed also by these reasons. For first, that it is round from East to West is proved by the Sun, Moon, and the other Stars, which are seen to rise, and set. first with those that inhabit more Eastwardly, and afterward with them that are farther West. The Sun riseth with the Persians that dwell in the Eastern parts, foure hours sooner than it doth with those that dwell in Spaine, more Westward: as Cleomedes affirmeth. The same is also proved by the observing of Eclipses, especially those of the Moon; which although they happen at the same time, are not yet observed in all places at the same hour of the day or night, but the hour of their appearing is later with them, that inhabite Eastward, then it is with the more Western people. An Eclipse of the Moon, which Ptolemy reports lib. 1 Geogr. cap. 4. To have been seen in Arbela, (a town in Assyria,) at the fift houre of the night; the same was observed at Carthage at the second houre. In like manner an Eclipse of the Sun, which was observed in Campania to be betwixt 7. and 8. of the Clock; was seen by Corbulo, a Captain in Armenia, betwixt 10. and 11. as it is related by Pliny. Now this is also

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also of a sphericall figure from North to South, may be clearly demonstrated by the risings, settings, elevations and depressions of the Stars, and Poles. The bright Star that shines so resplendently, in the upper part of the Sterns of the Ship, Argo, and is called by the Greeks $\alpha\delta\rho\alpha\sigma\theta$, is scarcely to be seen at all in Rhodes, unlesse it bee from some eminent high place: yet the same is seen very plainly in Alexandria, as being elevated above the Horizon, about the fourth part of a signe: as Proclus affirms in the end of his book, de Sphæra. For I read it, *Conspicue cernitur*; not as it is commonly, *Prorsus non cernitur*; notwithstanding, that both the Greek text, and also the Latine translation are against it. Another argument may bee taken, from the figure of the shadow, in the Eclipse of the Moon, caused by the interposition of the Earths opacous body: Which shadow being Sphericall, cannot proceed from any other then a round Globous body: as it is demonstrated unto us out of Opticall principles. But this one reason is beyond all exception: that those that make toward the Land at the Sea, shal first of all descry the tops of the hilles onely, and afterwards, as they draw nearer to shore, they see the lower parts of the same, by little and little: Which cannot proceed from any other cause, then the gibbosity of the Earths superficies.

As for those other opinions of the hollow, Cubicall, Pyramidall, and plaine figure of the Earth, you have them all largely examined both in Theon, (Ptolomies Interpreter) Cleomedes, and almost in all our ordinary Authours of the Sphere:
together

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together with the reasons why they are rejected. Let that old conceit of the plainnesse of the Earths superficies, is again now at last, tanquam Crambe recocta, set forth in a new dresse, and thrust upon us by Franciscus Patricius; who by some few cold arguments, and misunderstood experiments, endeavours to confirme his own, and consequently to overthrow that other received opinion of the sphericall figure of the Earth. I shall only lightly touch at his chiefest arguments; my present purpose and intention, suffering mee not to insist long on the confutation of them. And first of all, the great height of Hills, and the depression of vallies, so much disagreeing from the evennesse of the plain parts of the Earth, seem to make very much against the roundnesse of the Earth. Who can bear with patience, saith hee, that those huge high mountains of Norway, or the mountaine Slotus, which lies under the Pole, and is the highest in the world, should yet be thought to have the same superficies with the Sea lying beneath it? This therefore being the chiefest reason, that may seem to overthrow the opinion of the Earth, and Seas making up one sphericall body; let us examine it a little more nearly, and consider, how great this inequality may bee, that seems to make so much against the evennesse of this Terrestriall Globe. Many strange, and almost incredible things are reported by Aristotle, Mela, Pliny, and Solinus, of the unusuall height of Athos, an Hill in Macedonia, and of Calvus in Syria, as also of another of the same name in Arabia, and of the mountaine Caucasus. And among the rest, one of the most mi-

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*vaculous things which they have observed of the mountain Athos, is, that whereas it is situate in Macedony, it casts a shadow into the market place at Myrrhina, a Town in the Island Lemnos; from whence Athos is distant 86. miles. But for as much as Athos lies Westward from Lemnos, as may appeare out of Ptolomies Tables, no marvail that it casts so large a shadow: seeing that wee may observe by daily experience, that as well when the Sun riseth, as when it setts, the shadowes are always extraordinary long. But that which Pliny, and Solinus report of the same mountain, I should rather account among the rest of their fabulous Stories; where as they affirm it to be so high, that it is thought to be above that region of the aire whence the rain is wont to fall. And this opinion (say they) was first grounded upon a report that there goes, that the ashes which are left upon the Altars on the top of this hill, are never washed away, but are found remaining in heapes upon the same. To this may be added another testimony, out of the Excerpts of the seventh booke of Strabo, where it is said, that those that inhabite the top of this mountain, do see the Sun three hours sooner, then those that live neare the Sea side. The height of the mount. in Caucasus is in like manner celebrated by Aristotle, the top whereof is enlightened by the Suns flames, the third part of the night both morning and evening. No lesse fabulous is that which is reported by Pliny and Solinus of Calvus in Syria, from whose top the Sun rising is discovered about the fourth watch of the night: which is also related by Mela of that
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other *Calvus* in Arabia. But that all these relations are no other then meer fables, is acutely and solidly proved by *Petrus Noninus*, out of the very principles of Geometry. As for that which *Eustathius* writes, that *Hercules* pillars called by the Greeks *Calpe* and *Abenna*, are elevated by *Dionysius Perlegetes* for their miraculous height is plainly absurd and ridiculous. For these arise not above an hundred Ells in height, which is but a furlong: whereas the Pyramids of Egypt are reported by *Strabo* to equall that height; and some trees in India are found to exceed it: if we may credit the relations of those Writers, who in the same *Strabo* affirm, that there grows a tree by the river *Hyarotis*, that casteth a shadow as much, five furlongs long.

Those fabulous narrations of the Ancients, are seconded by as vaine reports of our modern times. And first of all *Scaliger* writes, from other mens relation, that *Tenariffe*, one of the Canary Islands, riseth in height fifteen leagues, which amount to above sixtie miles. But *Patricius* not content with this measure, stretcheth it to seventie miles. There are other hills in like manner cryed up for their great height; as namely the mountain *Andi* in Peru, and another in the Isle *Pico* among the *Azores* Islands: but yet both these fall short of *Tenariffe*. What credit the relations may deserve, we will now examine. And first for *Tenariffe*, it is reported by many writers to be of so great a height, that it is probable the whole World affords not a more eminent place; not excepting the mountain *Elotus* it self; which whether ever any other mor-

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all man hath seen, besides that Monke of Oxford (who by his skill in Magicke conveighed himself into the utmost Northerne regions, and took a view of all the places about the Pole, (as the Story hath it) is more then I am able to determine. Yet that this Isle cannot be so high as Scaliger would have it, wee may be the more bold to believe, because that the tops of it are scarcely ever free from snow: so that you shall have them covered all over with snow all the year long, save only one, or, at the most, two months in the midst of summer: as may appear out of the Spanilh Writers. Now that any snow is generated 60 or 70 miles above the plain superficies of the Earth and Water, is more then they will ever perswade us: seeing that the highest vapours never rise above 48 miles above the earth, according to Erastosthenes his measure; but according to Ptolomy, they ascend not above 41 miles. Notwithstanding Cardan, and some other profest Mathematicians, are bold to raise them up to 288 miles; but with no small stain of their name, have they mixed these trifles with their other writings. Solinus reports that the tops of the mountain Atlas reacheth very near as high as the circle of the Moon: but he betrayeth his own error, in that he confesseth that the top of it is covered with snow, and shineth with fires in the night. Not unlike to this, are those things which are reported of the same mountain, and it's height, by Herodotus, Dionytius Afer, and his scholiast Eustathius: whence it is called in Authors, Cœlorum column, the pillar that bears up the Heavens,
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But to let passe these vain prodigious relations : let us come to those things that seem to carry a greater shew of truth. Eratosthenes found by Dioptrickall instruments, and measuring the distances betwixt the places of his observation, that a perpendicular, drawn from the top of the highest mountain, down to the lowest bottom or vally, did not exceed ten furlongs. Cleomedes saith that there is no hill found to be above fifteen furlongs in height : and so high as this, was that vast steep rock in Bactriana, which is called Sifimित्र Petra, mentioned by Strabo in the 11 booke of his Geography. The topps of the Thessalian mountains are raised to a greater height by Solinus, then ever it is possible for any hill to reach. Yet if wee may believe Pliny, Diczarchus, being employed by the Kings command, in the same businesse, found that the height of Pelion, which is the highest of all, exceeded not 1250 pases, which is but ten furlongs. But to proceed yet a little further, least wee should seem too sparing herein, and so restrain them within narrower limits then wee ought : we will adde to the height of hills, the depth also of the Sea. Of which the illustrious Julius Scaliger in his 38. Exercitation against Cardan, writeth thus. The depth of the Sea (saith he) is not very great : for it seldome exceeds 80 pases, in most places it is not 20 pases, and in many places not above six, in few places, it reacheth 100. pases, and very seldome, or never exceeds this number. But because that falls very far short of the truth, as is testified by the daily experience of those that passe the Seas ; let us make the depth of
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the Sea equall to the height of mountains: so we suppose the depth thereof to bee ten furlongs, which is the measure of the Sardinian Sea, in the deepest places, as Posidonius in Strabo affirms. Or if you please, let it be fifteen furlongs, as Cleomedes, and Fabianus, cited by Pliny lib. 2. c. 102. will have it. (For Georg. Valla in his interpretation of Cleomedes, deales not fairly with his Author, when he makes him assign thirty furlongs to bee the measure of the Seas depth.) These grounds being thus laid, let us now see what proportion the height of hills may bear to the Diameter of the whole Earth: that so we may hence gather, that the extuberancy of hills are able to detract little or nothing from the roundnesse of the Earth; but that this excessency will bee but like a little knob or dust upon a ball, as Cleomedes saith. For if wee suppose the circumference of the whole earth to bee 180000 furlongs; according to Ptolomies account, (neither did ever any of the Ancients assigne a lesse measure then this; as Strabo witnesseth:) the Diameter thereof will bee, (according to the proportion betwixt a circle and it's Diameter found out by Archimedes,) above 57272. furlong. If then we grant the highest Hills to bee ten furlongs high, according to Eratosthenes and Dicæarchus; they will beare the same proportion to the Diameter of the Earth, that is, betwixt one and 5727. (Peucerus mistakes himself, when he saith, that the Diameter of the Earth to the perpendicular of ten furlongs is, as 18000. to one for this is the proportion it beareth to the whole circumference, and

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not the Diameter. Or suppose the topps of the highest hills to ascend to the perpendicular of fifteen furlongs, as Cleomedes would have it; the proportion then will be of one to 3818. Or if you please, let it be thirty furlongs, of which height is a certain rock in Sogdiana, spoken of by Strabo, in the eleventh Booke of his Geography, (notwithstanding Cleomedes is of opinion, that a perpendicular drawn from the top of the highest hill, to the bottome of the deepest Sea, exceeds not this measure;) the proportion will be no greater, then of one to 1908. Or let us extend it yet farther, if you will, to foure miles, or thirty-two furlongs, (of which height the mountain Casius in Syria is reported by Pliny to be,) the proportion will yet be somewhat lesse then of one to 1789. I am therefore so farre from giving any credit to Patricius his relation of Tenariffes, being seventy-two miles high, (unlesse it be measured by many oblique and crooked turnings and windings: in which manner Pliny measurcth the height of the Alpes also to be fifteen miles;) as that I cannot assent to Alhazen, an Arabian, who would have the topps of the highest hills to reach to eight Arabian miles, or eighty furlongs, as I think: neither yet to Pliny, who in his quarto lib. cap. 11. affirmes the mountain Hæmus to be six miles in height: and I can scarcely yeeld to the same Pliny, when as he speaks of other Hills four miles in height. And who-soever should affirm any Hill to be higher then this, though it were Mercury himself, I would hardly

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hardly believe him. That much of the height of hills, which seemed to derogate from the roundness of the Terrestriall Globe. Patricius proceeds, and goes about to prove that the world also is not round or sphericall. And he borroweth his argument from the observations of those that convey or leuell waters, who find by their Dioptricall Instruments; that waters have all an equall and plaine superficies, except they be troubled by the violence of winds. On the contrary side, Eratosthenes in Strabo affirms, that the superficies of the Sea is in some places higher, then it is in other. And he also produceth, as assertors of his ignorance, those Water-levellers, who being employed by Demetrius about the cutting away of the Isthmus, or neck of land betwixt Peloponnesus and Greece; returned him answer, that they found by their Instruments, that that part of the Sea which was on Corinth's side, was higher then it was at Cenchræe. The like is also storied of Sesostris, one of the Kings of Egypt, who going about to make a passage out of the Mediterranean into the Arabian gulf, is said to have desisted from his purpose, because hee found that the superficies of the Arabian gulf was higher then was the Mediterranean: as it is reported by Aristotle, in the end of his first Booke of Meteors. The like is also said in the same place, by the same Author, to have happened afterward to Darius. Now whether the Architects or Water-levellers, imployed by Demetrius, Sesostris, and Darius, deserve more cre-

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is, then those whom Patricius nameth, I shall not
much trouble my selfe to examine. Yet Strabo in-
debateth against Eratosthenes for attributing any
ebb emunencies, and depressions to the superficies
of the Sea. And Archimedes his doctrine is,
that every humid body, standing still and with-
out disturbance, hath a Sphericall superficies, whose
center is the same with that of the Earth. So that
we have just cause to reject the opinions, both of
those that contend that the superficies of the Sea is
plaine; as also of those that will have it to bee in
some places higher then in other. Although wee
cannot, in reason, but confesse, that so small a por-
tion of the whole Terrestriall Globe, as may be
comprehended within the reache of our sight, cannot
be distinguished by the helpe of any Instruments
from a plaine superficies. So that we may conclude
Patricius his agreement, which he alledgeth from
the experience of Water-conveighers, to be of no
weight at all.

But hee goes on, and labours to prove his
assertion from the elevation and depression, rising
and setting of the Poles, and Stars, which are
observed daily, by those that traverse the Seas:
all which, hee saith, may come to passe, al-
though the surface of the water were plaine. For
any Star be observed, that is in the verticall
point of any place; which way soever you tra-
uell from that place, the same Star will seem
to bee depressed, and abate something of its ele-
vation, though it were on a plaine superficies.
But there is something more in it then Patri-
cius takes notice of. For if wee got an equall
measure

The Preface.

measure of miles either towards the North, or towards the South; the elevation or depression of the Star, will alwayes bee found to bee equal: which that it can possibly bee so in a plaine superficies; is more then wee will ever bee able to demonstrate. If wee take any Star situate near the Equator; the same when you have removed thence 60. English miles, will be elevated about a degree higher, above the Horizon, whether the Star bee directly over your head, or whether you depart thence, what so it may bee depressed from your Zenith, for 30. or 30. or any other number of degrees. Which that it cannot thus bee; on a plaine superficies, may be demonstrated out of the principles of Geometry. But yet mee thinks, this one thing might have perswaded Patricius (being so well versed in the Histories of the Spanish Navigations, as his writings sufficiently testifie) that the superficies of the Sea is not plaine; because that the Ship called the Victory, wherein Ferdinand Magellane loosing from Spaine, and directing his course towards the South-west parts, passed through the Straights; called since by his name, and so touching upon the Cape of good hope, having compassed the whole World about, returned again into Spain. And here I shall not need to maintain the famous Voyages of our owne Countreymen, Sir Francis Drake, and Master Thomas Candish, not so well known perhaps abroad; which yet convince Patricius and the same error. And thus have wee lightly touched the chiefe foundations

The Persuader

that his cause is built upon: but as for
these ill understood experiments, which he brings
for the confirmation of the same, I shall let them
speak for themselves; for that they seem rather to subvert his opi-
on, then confirm it.

Thus having proved the Globe of the Earth
to be of a Spharicall figure, seeing that the E-
minency of the highest Hills hath scarcely the
true proportion to the Semidiameter of the
Earth, that there is betwixt 1. and 1000.
which how small it is, any one may easily per-
ceive: I hold it very superfluous to goe about to
prove, that a Globe is of a figure most proper and
fit to expresse, and represent the fashion of the Hea-
vens and earth, as being most agreeable to Nature,
easiest to be understood, and also very beautifull
to behold.

Now in materiall Globes, besides the true
and exalt description of places, which indeed is
the chiefest matter to be considered; there are
two things especially required. The first where-
of is the magnitude and capacity of them; that
there may be convenient space for the de-
scription of each particular place or region; the
second is the lightnesse of them, that so their
weight be not cumberfome. Strabo in his eleventh
book, would have a Globe to have ten foot

Diameter, that so it might in some rea-
sonable manner admit the description of particu-
lar places. But this bulk is too vast, to be
conveniently dealt withall. And in this regard,
I think that those Globes, of which I intend
to speake in this ensuing discourse, may justly

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bee preferred before all other, that have been
set forth before them; as being more capac-
ious then any other: for they are in Diameter
two foot, and two inches: whereas Mercator's
Globes, (which are bigger then any other ever
set forth before him,) are scarcely sixteen in-
ches Diameter. The proportion therefore of
the superficies of these Globes, to Mercator's,
will be as 1. to 2 $\frac{1}{2}$ and somewhat more, Ev-
ry Countrey therefore in those Globes will bee
above twice as large as it is in Mercator's:
so that each particular place may the more ea-
sily bee described. And this I would have to
bee understood of those great Globes, made by
William Saunderson of London; concerning
the use of which especially, wee have written this
discourse. For he hath set forth other smaller
Globes also, which as they are of a lesser bulke
and magnitude, so are they of a cheaper price:
that so the meaner Students might herein also bee
provided for. Now concerning the Geographi-
call part of them, seeing it is taken out of the
newest Charts and descriptions; I am bold to
think them more perfect then any other: how ever
they want not their errors. And I think it may
bee the Authors glorie to have performed thus
much in the edition of these Globes. One thing
by the way you are to take notice of: which is, that
the descriptions of particular places are to bee
sought for else where; for this is not to bee ex-
pected in a Globe. And for these descriptions of
particular Countries, you may have recourse to
the Geographical tables of Gerardus Mercator,
whose

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whose diligence and industry in this Regard seems
to exceed all other before him. To him, therefore we
referre you.

PONT. STRABO in the place above,
cited by the Author, speaks of a *Globe* of that
bignesse, not such an one as himself had made
but such an one as he could wish were made;
that so it might be every way absolute. And in-
deed with In this age of ours, the magnificent
and Illustrious *Tycho Brabe*, who is now de-
servedly celebrated with the title of a *Second*
Atlas, hath made a very faire *Cœlestiall Globe*
composed all of wood within, and covered
over with plates of Copper, artificially
wrought, containing sixe foot in Diameter,
besides the Meridian, and Horizon, and other
appendances which may be guessed at by the
rest. the like whereof, so coldly and elaborates-
ly framed, and every way exactly answering it
self, I think was never made by any. And in-
deed, it is a vast and magnificent piece of
worke: insonuch that many strangers came
out of divers parts into *Denmarke*, while it
was there, onely to see this *Globe*. But *Tycho*
afterward betaking himselfe to the Emperours
Court, caried this *Globe* with some certaine
other Mathematicall instruments with him.
All which after the death of *Tycho*, were
bought for a great sum of money by the Em-
perour, and are now preserved at *Prage* in the
Imperiall Castle, and shewed among other
rarities there. About the Horizon are read these
words, written in letters of gold.

The Preface.

Anno a Christo nato CIO. 15. XXCIV,
Regnante in Dania Frederico secundo, hunc Celesti
machina conformem Globum, in quo affinis
octava Sphæra sidera calidis organis deprehensa,
suis quaque locis ad amissim representare, Erra-
trunque stellarum per hac apparentias perperuesti-
gare decrevit, cælo terrigenis, qui rationem non
capiunt, Mechanico opere patefacto, TYCHO
BRACHE, O. F. Sibi & posteris
F. F.

Which *Globe*, by reason of its extraordinary
magnitude, hath this prerogative above all
other: that all things may be done upon it most
exactly, and in the very minute, especially as
farre as concerns the doctrine of the *First*
mouenble, together with the observations of
the *Scarres*, and their aspects in respect of the
Ecliptick and *Aequator*: all which may be
done mechanically, without any tedious com-
putations.

The great *Duke* of *Tuscany* hath also two
very faire *Globes*, as large as this, but made after
the ordinary manner; the one a *Terrestrial*
Globe: but the other an *Armillary Sphære*, con-
sisting of *Circles*, and *Orbes* only.

Now concerning those *Globes* of *Mercator*,
Spoken of by our *Author*, the same have been since,
accurately corrected, according to *Tycho's* obser-
vations, and set forth both in a great, and lesser forme
by *J. Hondius*, and are still made, and sold by his
Son.

And because that in this ensuing discourse of
Globes, there is often mention made of a *Point*,
Line,

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Line, Superficies, Angle, Rhombus; Axis, and other the like Geometrical termes: I have thought good to set down the severall definitions of the same.

A Point, is that which hath no parts: or being supposed to be indivisible, or that cannot be divided into parts.

A Line, is a supposed length without breadth; whose extremes or bounds are two Points.

A Right Line, is the shortest of all Lines, drawn from any two of the same Points.

Parallels, are Lines equidistant from each other: which though they should be protended infinitely, would never meet in any point: but keep still the same distance mutually.

A Perpendicular, is a right Line, falling directly on a Right Line; and making on each side that Point where they touch, two equall Right Angles.

A Superficies, is a Longitude, having only Latitude: whose termes and limits are two Lines.

A Figure, is that which is comprehended within one, or many bands: under one band is comprehended a Circle: and all other Figures under many.

A Term or Limit, is that which is the end of anything.

A Circle, is a plane Figure, comprehended under one round line: in the midst whereof there is a Point, from whence all Lines drawn to the Circumference are equall.

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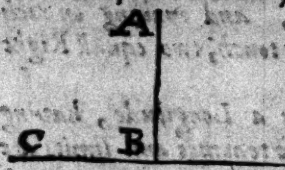
The Center of a Circle, is that point in the midst, from which all equall lines are drawn to the Circumference.

The Diameter of a Circle, is a Right line passing through the Center, terminated at each end with the Circumference, and dividing the Circle into two equall Parts.

A Semicircle, is the halfe of a Circle, contained within the Diameter, and halfe the Circumference.

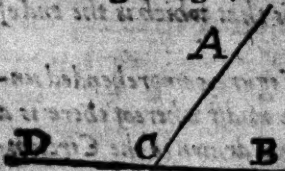
An Arch, is a portion of a Circle, comprehended within a Right line, and any part of the Circumference, and is alwayes either greater or lesser then a Semicircle.

An Angle is, when two lines are extended upon the same superficies, so that they touch one another in a Point, but not directly.



A Right Angle, is that which is produced of a Right line, falling upon a Right line; and making two equal Angles, on each side the Point, where they touch each other: As the Lines A, B, C.

An Obtuse Angle, is that which is Greater then a Right Angle, as the Angle A, C, D.



An Acute Angle, is that which is lesse then a Right: as the Angle A, C, B.

A Solid Angle, is that which is comprehended under

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Under more then two plaine Angles, which are not in the same superficies and meeting all in one point: as are the Angles of a Cube, or Die.

Rhombus, is a Figure Quadrangular, having equall sides, but not equall Angles.

Rhomboides, is a Figure having neither equal sides, nor equall Angles: yet the Opposite sides and Angles are equall.

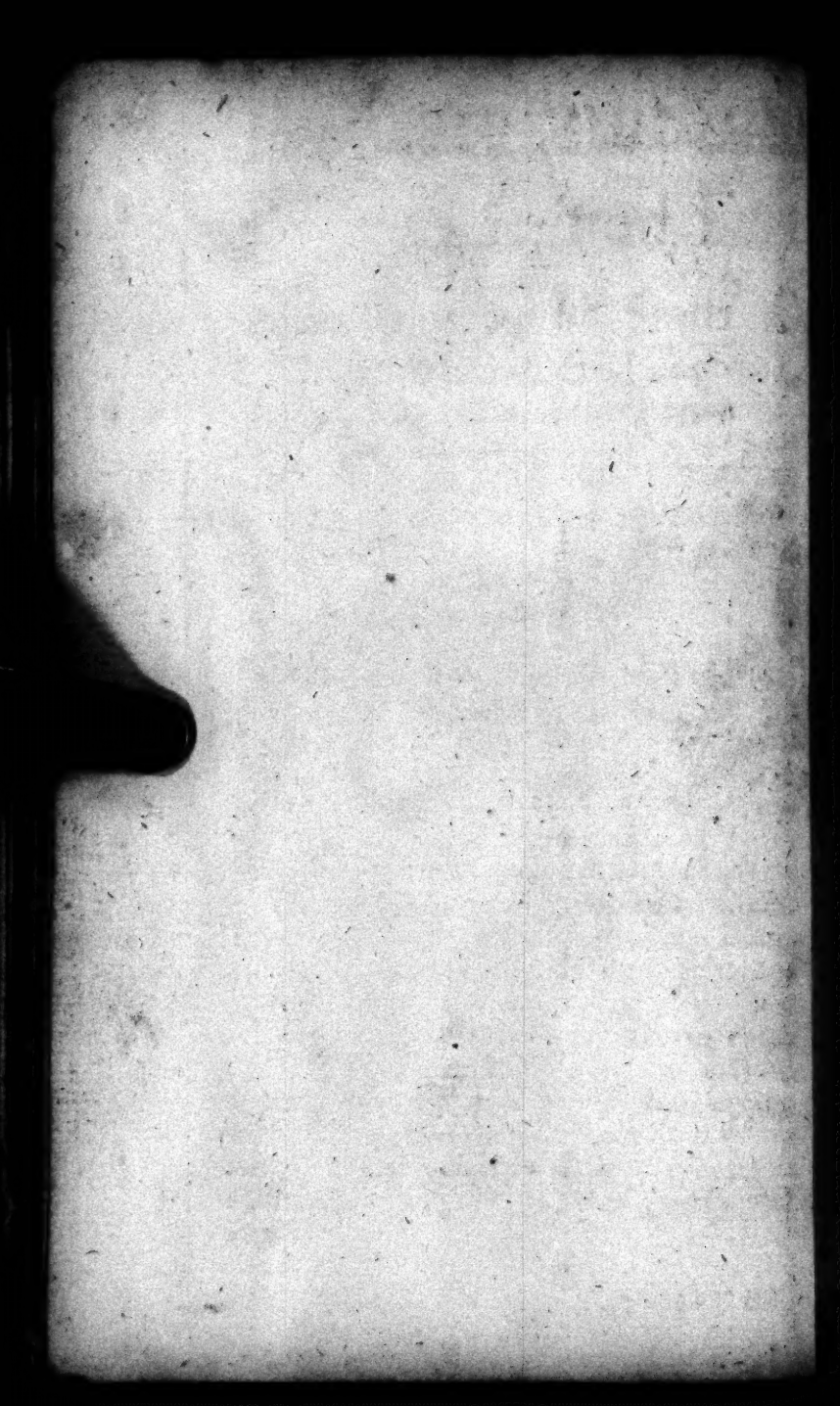
A solid Body, is that which hath length, breadth, and thickness; as a Cube or Die: and the Limits or Extreames of it are superficies.

The Axis is that Diameter, about which the sphere or Globe is turned.

The Poles of a Sphere, are the Extreames, or Ends of the Diameter, and are terminated in the superficies of the Sphere.

A Sphere is defined by Euclide to be, when the Diameter of a semicircle remaining fixed, the Semicircle is turned about, till it returne again to the place, whence it began to move at first.






The first Part, Of those things which are common both to the Cælestiall and Terrestriall *GLOBE*.

CHAP. I.

*What a Globe is, with the parts thereof: and of
the Circles of the Globe,*

Globe, in relation to our present purpose, we define to be an Analogicall representation either of the Heavens, or the Earth. And we call it Analogicall, not only in regard of it's forme, expressing the Sphericall figure, as well of the Heavens, as also of the Terrestriall Globe, consisting of the Earth it self, together with the interflowing Seas: but rather because that it representeth unto us in a just proportion and distance, each particular constellation in the Heavens, and every severall region and tract of ground in the Earth, together with certaine circles, both greater and lesser, invented by Artificers for the more ready computation of the same. The greater Circle we call those, which divide

divide the whole superficies of the Globe into two equall parts, or halves; and those the lesser, which divide the same into two unequal parts.

PONT. A Globe is also called a Sphere: anely with this distinction, that a Sphere is properly such an one, as consists only of circles or little hoopes of brasse, or like matter, and is not a solid body, as is a Globe: the Latines call it *Armillaris*. Now those Circles whereof it is made, although we are not to conceive that there are any such reall ones in the Heavens; yet they have been invented by Artificers, to the end, that by means of the same, the doctrine of the true motions of the Celestiall bodies might the more easily bee apprehended. And what is said of the Equator, Zodiacque, Axes, and the other Circles, is also to be understood of the other Orbs themselves, and their Hypotheses. For as concerning the objection made long since by Rheteticus, and lately by Peter Ramus lib. 2. Schol. Math. touching the facility the ancient Egyptians had in searching out the courses of the Stars: I think it not amisse to let you see what the Noble Tycho's opinion is herein, and what answer hee, once upon occasion gave Ramus himselfe, proposing the same unto him: as wee find it related by himself in his book of Astronomicall Epistles pag. 60. And thus it is.

Quod celeberrimus ille nostri ævi Philosophus Petrus Ramus, &c. Whereas that famous Philosopher of our times, Peter Ramus, was of opinion, that the Science of Astronomy might be framed by some certain Logically wayes of computation,

Celestiall and Terrestriall Globe.

utation, with Hypotheses: this is nothing else
but a more ground-lesse conjecture. Which com-
ment of his, he proposed indeed to mee about sixteen
years since, when as we were together at Au-
spurge: wishing mee wishfull, that when as I had
once reduced the course of the Stars into some
small order, by the Hypotheses now in use; I
would then try what might be done without them.
And that this might possibly be effected, he brought
this for his reason, because that hee had read, that
the Egyptians, had anciently a most easie and
facile way and method in their Astronomy. And
therefore, seeing that this way of computation by
Hypotheses is very intricate and difficult, it must
needs follow, that they had a more plain and com-
pandious way to the knowledge of the course
of the Stars, and that without them. But
I opposed him herein, showing wishall, that it was
altogether impossible that the Celestiall Apparen-
ces should bee reduced into any certain order or
science, so as to be understood, without the helpe
of Hypotheses. And that this facility of the
Egyptians was onely in the Equators of the
Planets, whereby they freed themselves from all
tedious supputation; Whereas, the easie and facile
use of the Ephemerides was not as yet brought to
light. But for as much as hee (though otherwise a
man of an excellent apprehension and wit, and a
great lover of the truth) seemed not to bee so
thoroughly acquainted with the hidden secrets of
this intricate Science, and considered not that the
course of the Heavenly bodies did not keepe a con-
stant period at any set time: I neither could nor
indeed

indeed desired to get any thing of him, in this manner. He hath many Sectaries at this day, who have a strong faith of the possibility of this thing: but such they are, that neither understand the matter themselves, nor will ever be able to bring it to any effect. For seeing that all things consist in number, weight, and measure: without these, there is no any thing in this visible world that can be explained or understood. Now the office of these Hypotheses is only to shew the measure of the apparent motion of the Heavenly bodies, by circles and other figures: which are again resolved into numbers by Arithmeticks, without which, whosoever shall think to attaine to the knowledge of the motion of the Stars: he may be said to invoke Fortune, (as the Proverb is:) and dreames of some strange incorporeall, and more then Seraphicall way, above the reach of humane capacity.

Besides the body of the Globe it self, and those things which we have said to be thereon inscribed, there is also annexed a certain frame, with necessary instruments thereto belonging, which we shall declare in order.

— The fabrick of his frame is thus: First of all, there is a Base, or foot to rest upon: on which they are raised perpendicularly fixe "Pillars" or "Columnes, of equall length and distance; upon the top of which there is fastened to a leuell, and parallel to the Base, a round plate or circle of wood, of a sufficient breadth and thicknesse, which they call the *Horizon*: because that the uppermost superficies thereof performeth the office of the true *Horizon*. For

Celestiall and Terrestriall Globe.

is so placed, that it divideth the whole Globe into two equall partes. Whereof that which is uppermost, representeth unto us the visible Hemisphere, and the other, that which is hid from us. So likewise that Circle which divideth that part of the world which we see, from that other which we see not, is called the *Horizon*. And that point which is directly over our heads in our Hemisphere, and is on every side equidistant from the *Horizon*, is commonly called *Zenith*: but the *Arabians* name it *Septentrion*. But the former corrupted name hath yet prevailed; so that it is always used among Writers generally. And that point which is opposite to it in the lower Hemisphere, the *Arabians* call *Nathire*; but it is commonly written *Nadir*. These two points are called also the *Poles* of the *Horizon*.

Furthermore, upon the superficies of the *Horizon* in a materiall Globe there are described, first, the twelve Signes of the *Zodiaque*: and each of these is again divided into twenty lesser portions: so that the whole *Horizon* is divided into 360. parts, which they also call degrees. And if every degree be divided into sixty parts also, each of them is called a *Scruple* or *Minute*: and so by the like subdivision of *Minutes* into sixty parts, will arise *Seconds*, and of these *Thirds*, and likewise *Fourths*, and *Fifths*, &c. by the like partition still of each into sixty parts.

P O N T. In the midst among these Signes are there described certain Characters, to denote the particular

particular Planet, to whose dominion each Sign
doth appertain. Next to this there is another
Section, wherein are set down the severall dayes
of every week: after that, followeth the number
of the dayes of every Moneth, throughout the
whole yeare. Besides this number of the dayes, part
of them hath in their severall endes some one
of these three letters affixed, K. N. I. signifying the
Kalends, Nones, and Ides, which as amongst the
Ancient Romans used in their accounts, to signify
the dayes of every Month. For they did not
reckon as we doe now, from the first day of any
Month to the 30. or 31. of the same; but their
account was according to the Kalends, Nones,
and Ides. So that the first of each Month was
the Kalends; and the rest of the dayes of the same
month were not reckoned forward, but after an
etrograde manner. As for example: The last
day of December, which is the 31. They
called the second of the Kalends or January, and
the 30. of the same month, the third of the
Kalends of January. Thus reckoning backward
till they came to the Ides, which was the four-
teenth of December, and the nineteenth of the
Kalends of January. The like order they obser-
ved in the Ides and Nones also. Now what months
have more or fewer Kalends or Nones may be found
upon the Horizon, as we have said: and as may be
gathered also out of these old verses,

Majus sex Nonas, October, Julius, & Martius
Quatuor ac reliqui. Tenet Idus quilibet octo.
Ind dies reliquos die omnes esse Calendas.

Then

Celestiall and Terrestiall Globe.

There is also described upon the *Horizon* the *Romane Calender*, And that three several waies: to wit, the ancient way, which is still in use with us here in *England*; and the new way, appointed by Pope *Gregory 13.* Wherein the *Equinoxes* & *Solstices* were restored to the same places, wherein they were at the time of the celebration of the Councell of *Nice*: and in the third, the said *Equinoctial* and *Solstitial* points are restored to the places that they were in, at the time of our Saviour *Christ's* nativity. The months in the Calender are divided into dayes and weekes: to which are annexed, as their peculiar characters, the seven first letters of the Latine Alphabet. Which manner of designing the dayes of the moneth, was first brought, in by *Dionysius Exiguus*, a *Romane* Abbot, after the Councell of *Nice*.

The innermost border of the *Horizon* is divided into 32. parts, according to the number of the winds, which are observed by our moderne Sea-faring men in their Navigations; by which also they are wont to designe forth the quarters of the Heavens, & the coasts of Countries. For the Ancients observe but foure winds only: to which were after added foure more: but after ages, not content with this number, increased it to twelve and at length they brought it to twenty foure, as *Strabo* & *us* notes. And now these later times have made them up thirty two, the names whereof, both in *English* and *Latine* are set down in the *Horizon* of *Materiall Globes*.

PONT.

PONT. The true Horizon is either Rational or Sensible. The Rational or Intelligible Horizon divide the Sphere into two equall parts exactly, and these are called the upper and the lower Hemispheres. The sensible or apparent Horizon, is called, because it only seems to divide the Heavens into two equall parts, or Hemispheres; whereas indeed it doth not divide it so exactly, but only seemeth so to doe. The Rational Horizon, is also called the artificiall, because that it was brought in, for the use of Astronomy.

The use of the Horizon is manifold. First, it divides the Heavens into two Hemispheres. Secondly, it sheweth what Starres never set, and so what never rise from under the Earth; and so, likewise what Stars do both rise, and set. Thirdly, it shewes the cause of the equality, and in equality of the artificiall dayes and nights. Fourthly, it conduceth to the finding out of the latitude of any place. Fifthly, it is the cause of the Rectitude and obliquity of the Sphere; whereof we have occasions to speak more largely hereafter.

There is also let into this Horizon, two notches opposite one to the other, a circle of brasse, making right angles, with the said Horizon, and plac'd, so that it may be moved at pleasure up and down, by those notches, as need shall require. This circle is called the

The Meri-
dian.

Meridian, because that one side of it, which is in like manner divided in 360. degrees, supplyeth the office of the true *Meridian*. Now the *Meridian* is one of the greater circles, passing through the Poles of the world, and also

of

Celestiall and Terrestriall Globe.

of the Horizon: to which, when the Sun in his daily revolution is arrived in the upper Hemisphere, it is midday; and when it toucheth the same in the lower Hemisphere, it is midnight, at that place whole *Meridian* it is.

These two circles, the *Horizon* and *Meridian*, are various and mutable in the Heavens and Earth, according as the place is changed. But in the materiall Globe, they are made fixed and constant: and the earth is made moveable: that so the *Meridian* may be applied to the verticall point of any place.

PONT. The uses of the *Meridian* are these, especially. First, It determineth the point of mid-day, and midnight: whence the Astronomers begin the day alwayes from the Circle. Secondly, in the *Meridian* is observed the Zenith or verticall point of places, whence afterward the distances of Stars and Parallel circles are gathered. Thirdly, The Longitude and Latitude of places are taken from hence. Fourthly, It shewes the greatest elevation of the Sun, and other Stars: which elevation is called their *Meridian Altitude*. Fifthly, By the Meridionall elevation of the Sun, when hee is in the Equinoctiall point, may be found out the elevation of the Pole, and habitude or position of the Sphere. For the quarter of a circle being 90. degrees, if then we substract the Meridionall Altitude of the Sun in the Equinoctiall from 90. degrees, the remainder sheweth the elevation of the Pole. As for example, The elevation of the Sun at noon, when it is in
the

the *Equinoxe*, is about 38. degrees with us here at London: which being deducted out of 90. there remaines 52. Which is the elevation of the Pole with us. So at Rome the *Equinoctiall altitude* of the Sun is about 48. degrees; which being subtracted from 90 degrees; which is a *Quadrant*, there remaines 42. for the elevation of the Pole.

The Poles
and Axis.

In two opposite points, of this *Meridian*, are fastened the two ends of a iron pin, passing through the body of the *Globe* and its Center. One of which ends is called the *Arcticke*, or North Pole of the world; and the other the *Antarctick*, or South Pole: and the pin it self is called the *Axis*. For the *Axis* of the world is the *Diameter* about which it is turned. And the extreame ends of the *Axis* are called the *Poles*.

The Houre-
Circle.

To either of these *Poles*, where need shall require, there is a certain brasse circle or ring, of a reasonable strong making, to be fastened, which circle is divided into 24. equal parts, according to the number of the hours of the day & night: and it is therefore called the *Houre-circle*. And this circle is to be apply'd to either of the *Poles* in such sort, as that the Section where 12. is described, may precisely agree with the points of mid-day, and mid-night in the superficies of the true *Meridian*.

There is also a nother little pin, or stile to be fastened to the end of the *Axis*, in the very center of the *Houre-circle*; and this pin is called in Latine, *Index Horarius*: and is so made, as that it turnes about and pointeth so every

Celestiall and Terrestriall Globe,

of the 24. sections in the *Hour-circle*, according as the *Globe* it selfe is moved about: so that you may place the point of it to what hour you please.

PONT. The use of this *Hour-circle* and *Index* is to denote the houres of the rising and setting of the *Sun* and other *Starrs*, which must be practised after this manner. First, you must set the *Globe* to your elevation or *Pole*; and then apply the degree of the signe, in which the *Sun* at the time is, to the *Meridian*, and the *Index* to the twelfth houre which is uppermost. And so having thus done, you must turne the *Globe* about, till the degree wherein the *Sun* is, come to the Eastern side of the *Horizon*; which done, the *Index* will point out the houre of his rising, and if you turne it about to the West side, you shall in like manner have the houre of his setting.

There is also belonging to the *Meridian* a *Quadrant* of *Altitude*, being made of a long thin plate of *steele* or *brasse*, and fashioned crooked, so that it maybe apply'd to the convex *Superficies* of the *Globe*, and having the fourth part of the circle in length. The *Quadrant*. And this *Quadrant* is made in such a sort as that it may be fastened on the *Meridian*, and so be applyed to the *Zenith* of any place what soever, being divided from one end to the other into 90. equall parts or degrees.

There is besides at the foot of the *Globe*, a *Mariners compass* placed: which serves to show how to place the *Globe* rightly, according to the four winds or quarters of the world.

CHAP. II.

Of the Circles which are described upon the Superficies of the Globe.



And now in the next place we will shew what Circles are described upon the Globe it selfe. And first of all, there is drawn a circle, in an

The Equator.

equall distance from both the Poles, that is 90. degrees, which is called the *Equinoctiall*, or *Equator*; because that when the Sun is in this Circle, dayes and nights are of equal length in all places. By the revolution of this Circle is defended a *Naturall* day, which the *Greeks* call *ἡμέρα*. For a day is twofold; *Naturall* and

A day Naturall and Artificiall.

Artificiall. A *Naturall* day is defined to be the space of time, wherein the whole *Equator* makes a full revolution; and this is done in 24. hours. An *Artificiall* day is the space, wherein the Sun is passing thorough our upper Hemisphere: to which is opposed the *Artificiall* night, while the Sun is carried about in the lower Hemisphere. So that an *Artificiall* day and night are comprehended within a *Naturall* day.

Hours equall and unequal.

The Parts of a day are called *houres*; which are either *Equall* or *Unequall*. An *Equall* hour is the 24. part of a *Naturall* day, in which space, 15. degrees of the *Equator* do alwayes rise, and as many are deprelled on the opposite part. An *Unequall* hour is the 12. part of

Celestiall and Terrestriall Globe.

an Artificiall day, betw. xt the time of the Sun rising and setting again. These hours are againe divided into Minutes. Now a Minute is the 60. part of an hour: in which space of time, a quarter of a degree in the Æquator, that is, 15. minutes do passe, and as many set.

PONT. The use of the Æquator consists chiefly in these things. First, it sheweth the time of the Æquinoxes, which are alwayes when the Sun fallies upon the Æquinoctiall circle. And this is, whenas the Sun enters into the first degree of Aries and Libra: according to that of Manilius.

Libra Ariēsq; parem reddunt noctemq; diemq;
In English thus.

The Sun in Libra, and Aries plac'd, each yeare:
The day and night are equall every where.

Secondly, the Æquator divides the Heavens into two equall parts, or Hemispheres. whereof one is called the Septentrionall or Northern Hemisphere: the other, the Meridionall or Southerne. Thirdly, it sheweth the ascension and descension of the parts of the Zodiack: whence the length of the Artificiall day and night, for any position of Sphere, may be known. Fourthly, it shewes what Stars, and parts of the Eclipticke have any Declination.

The Æquator is crossed, or cut in two opposite points, by an oblique Circle, which is called the Zodiack. The obliquity of this Circle is said to have been first observed by Anaximander Milestus, in the 58. Olympiad. as Pliny writeth in his lib. 2. Cap. 8, who also in the

same place affirms, that it was first divided into 12 parts, which they call *Signes*, by *Clavius Ptolemaeus*, in like manner as we see it this day. Each of these *Signes* is again subdivided into 30. parts: so that the whole *Zodiack* is divided, in all, into 360. parts, like as the other circles are. The first twelfth part whereof, beginning at the Vernal Intersection, when the *Aequator* and *Zodiack* crosse each other, is assigned to *Aries*, the second to *Taurus*, &c. reckoning from West to East. But here a young beginner in Astronomy may justly doubt, what is the reason, that the first 30. degrees or 12. part of the *Zodiack* is attributed to *Aries*, whereas the first Star of *Aries* falls short of the Intersection of the *Aequinoctiall* and *Zodiack* no lesse then 27. degrees. The reason of this is, because that in the time of the Ancient *Greekes*, who first of all observed the places and situation of the fixed Starrs, and expressed the same by *Asterismes* and constellations, the first Star of *Aries* was then a very smal space distant from the very Intersection. For in *Thales Milesius* his time, it was two degrees before the Intersection: in the time of *Meton* the *Athenian* it was in the very Intersection: in *Timocharis* his time it came two degrees after the Intersection. And so by reason of it's vicinity, the Ancients assigned the first part of the *Zodiack* to *Aries*, the second to *Taurus*; and so the rest in their order: as it is observed by succeeding ages, even to this very day.

PONT. Thales Miletius was the first that calculated the time of the *Æquinoxes* and *Eclipses*: and he flourished about the yeares of the Creation, 3370. which was about 634. yeares before Christ, Meton lived about 431. yeares before Christ, in the yeare of the Creation, 3517. He was the Son of Pauf-nia, and was a man of excellent knowledg in *Astronomy*. He also first invented the *Moones Circle* of 19. yeares: whose first new Moon fell upon the 13 day of the month *Scrriophorion*, which is the same with our 16 of June, being on a Friday. Vid. *Diodorum Siculum*. *Censorinus* writes of him thus. *Præterea sunt &c.* There are (saith he) besides many other great yeares: as the *Metonicall yeare* which Meton the Athenian invented and consisted of 19. common yeares &c. *Timochares* was by nation an *Alexandrian*, and he lived 300. yeares before Christ.

Vnder this Circle, the Sun and the rest of the Planets finished their severall courses and periods, in their severall manner and time. The Sun keepes his course in the midst of the *Zodiaque*, and therewith describeth the *Ecliptick* circle. But the rest have all of them their latitude and deviations from the Suns course, or *Ecliptick*. By reason of which their digressions and extravagations, the ancients assigned the *Zodiaque* 12. Degrees of Latitude. But our moderne *Astronomers*, by reason of the Evagations of *Mars*, and *Venus*, have added on each side two degrees more: so that the whole latitude of the *Zodiaque* is confined

within 16. degrees. But the *Ecliptick* onely is described on the *Globe*, and is divided, in like manner as the other circles, into 360. degrees.

PONT. The whole latitude of the *Zodiack* is divided into two parts by the *Ecliptick*, which is the circle, or *Circumference* under which the *Sun* steeres his course continually. whence it is called in *Latine*, *Via Solis*, & *Orbita Solis*, the *Sun* high way. And in *Greek*, $\alpha\lambda\alpha\theta\epsilon\iota\alpha$ $\mu\alpha\theta\eta\tau\iota\varsigma$ $\tau\omicron\upsilon\tau\omicron\upsilon$ $\eta\mu\epsilon\rho\omega\varsigma$, a Circle divideing the *Zodiack* in the midst. And it is called the *Ecliptick*, because the *Eclipses* of the *Sun* and *Moon* never happen, but when they are either in conjunction or opposition under this line, or very near the same.

The *Sun* runneth thorough this Circle in his yearly motion, finishing every day in the year almost a degree by his *Meane* motion, that is 59. minutes, 8. seconds. And in this space, he twice crosseth the *Æquator*; in two points equally distant from each other. So that when he passeth over the *Æquator*, at the beginnings of *Aries* and *Libra*, the dayes and nights are then of equal length. And so likewise when the *Sun* is now, at the farthest distance from the *Æquator*, and is gotten to the begining of *Cancer*, or *Capricorne*, hee then causeth the *Winter* and *Summer Solstices*. I am not ignorant, that *Vitruvius*, *Pliny*, *Theop Alexandrinus*, *Censorinus*, and *Calurnella* are of another opinion; (but they are upon another ground,) when as they say, that the

Æquinoxes

Equinoxes are, when as the Sun passeth through the eighth degree of *Aries* and *Libra*, and then it was the midst of Summer and winter, when the Sun entered into the same degree of *Cancer* and *Capricorne*. But all these Authours defined the Solstices by the returning of the shadow of Dials: which shadow cannot be perceived to return back again, as *Theon* saith, till the Sun is entered into the eighth degree of *Libra* and *Aries*.

PON I. The office and use of the *Zodiack* is. First, in that, it is a rule or measure of the proper motion of the Planets. Secondly, By the helpe of the *Zodiack* the true place, of all the Starrs are found: besides it may be knowne in what signe any fixed Starr or Planet may be said to be. Thirdly, It sheweth the Latitude of the Planets and fixed Starrs, Fourthly, All Eclipses happen when the Sun and Moon are under the *Ecliptique*. Fifthly, The obliquity of the *Ecliptique* is the cause of the inequality of the artificial dayes and nights.

The space wherein the Sun is finishing his course through the *Zodiack*, is defined to be a *Yeare*, which consists of 365. dayes, and almost 6. hours. But they that thinke to find the exact measure of this period, will find themselves frustrate: for it is finished in an un-equall time. It hath been alwayes a controversie very much agitated among the *Ancient Astronomers*, and not yet determined. *Philolaus* a *Pythagorean* determines it to bee 365. dayes: but all the rest have added something more

more to this number. *Harpalus* would have it to be 365. dayes and a halfe: *Democritus* 365. dayes and a quarter, adding besides the 18 parts of a day. *Oenopides* would have it to be 365. dayes and almost 9. hours. *Meton* the *Athenian* determineth it to be 365. dayes, 6. hours, and almost 19. minutes. After him *Calippus* reduced it to 365. dayes and 6. hours, which account of his was followed by *Aristarchus* of *Samos*, and *Archimedes*. of *Syracusa*. And according to this determination of theirs, *Julius Caesar* defined the measure of his Civile yeare, having first consulted (as the report goes) which one *Sofigines* a *Peripateticus*, and a great Mathematician. But all these, except *Philolaus*, (who came short of the just measure) assigned too much to the quantity of a yeare. For that it is somewhat less then 365. dayes, 6. houres, is a truth, confirmed by the most accurate observations of all times, and the skillfullest Artists in Astronomicall affaires. But how much this space exceedeth the just quantity of a yeare, is not so easie a matter to determine. *Hipparchus*, and after him *Ptolemy* would have the 300. part of a day substracted from this measure: (for *Jacobus Christmannus* was mistaken, when he affirmed, that a Tropicall yeare, according to the opinion of *Hipparchus* and *Ptolemy*, did consist of 365. dayes, and the 300 part of a day) For they doe not say so, but that the just quantity of a yeare is 365. dayes, and 6. hours abating the 300. part of a day: as may be plainly gathered out of

of *Ptolomy*, *Almagest*. lib. 3. Cap. 2. and as *Christmannus* himselfe hath also where rightly observed. Now *Ptolomy* would have this to be the just quantity of a yeare perpetually and immutably: neither would he be perswaded to the contrary, notwithstanding the observations of *Hipparchus*, concerning the inequality of the Sun's periodical revolution. But yet the observations of succeeding times, compared with those of *Hipparchus*, and *Ptolomy*, doe evince the contrary. The *Indians* and *Jewes* subtract the 120. parte of a day: *Albatroginus* the 600. part: the *Persians* the 115. part: according to whose account *Messahalah* and *Albunassar* wrote the tables of the Mean motion of the Sun. *Azaphus*, *Avarinus*, and *Azachel* affirmed that the quantity assigned was too much, by the 126. parte of a day. *Alphonfus* abateth the 122. part of a day: some others, the 128. and some the 130. part of a day. Those that were lately employed in the restitution of the *Romane Calendar*, would have almost the 133. part of a day to be subtracted, which they conceived in 400. yeares, would come to three whole dayes. But *Copernicus* observes that this quantity fell short, by the 115. part of a day. Most true therefore was that conclusion of *Censorinus*, that a year consisted of 365. dayes, and I know not what certain portion, not yet discovered by *Astrologers*.

By these divers opinions here alledged, is manifestly discovered the error of *Dion*, which is

is indeed a very ridiculous one. For he had a conceit that in the space of 1461. *Julian* yeares, there would be wanting a whole day for the just measure of a yeare; which he would have to bee intercalated, and so the *Civile Julian* yeare would accurately agree with the revolution of the Sun. And *Galen* also, the Prince of Physicians, was grossely deceived, when he thought that the yeares consisted of 365. dayes, 6. hours, and besides almost the 100. part of a day: so that at every hundred yeares end there must be a new intercalation of a whole day.

Now because the *Julian* yeare, (which was instituted by *Julius Caesar*, and afterward received, and is still in use) was somewhat longer then it ought to have been: hence it is that the *Equinoxes* and *Solstices* have gotten before their ancient situation in the Calendar. For about 432. yeares before the Incarnation of our Saviour *Christ*, the Vernal *Equinox* was observed by *Meton* and *Euthymon*, to fall on the eighth of the Kalends of *April*, which is the 25. of *March*, according to the computation of the *Julian* yeare. In the year 146. before *Christ* it appears by the observations of *Hipparchus*, that it is to be placed on the 24. of the same month, that is the 9. of the Kalends of *April*. So that from hence we may observe the error of *Sosigenes* (notwithstanding he was a great Mathematician) in that above 100. yeares after *Hipparchus*, in instituting the *Julian* Calendar, he assigned the *Equinox*

The mutation
of the
Equinox.
and *Solsti*
ces,

Equinox to be on the 25. of *March*, or the eight. of the Kalends of *Aprill*, which is the place it ought to have had almost 400. yeares before his time. This error of *Sosigenes* was derived to succeeding ages also: in so much that in *Galens* time, which was almost 200. yeares after *Julius Caesar*, the Equinoxes were wont to be placed on the 24. day of *March* and *September*: as *Theodorus Gaza* reports. In the yeare of our Saviours Incarnation, it happened on the 10. of the Kalend. of *Aprill*, or the 23. of *March*. And 140. yeares after, *Ptolomy* observed it to fall on the 11. of the Kalends. And in the time of the Councill of *Nice*, about the yeare of our Lord 328. it was found to be on the 21. of *March*, or the 12. of the Calends of *Aprill*. In the yeare 832. *Thebit Ben Choram* observed the Vernal Equinoxe to fall on the 17. day of *March*: in *Alfraganus* his time it came to the 16. of *March*. *Arzachel* a Spaniard in the year 1090. observed to fall on the Ides of *March*, that is the 15. day. In the year 1316. it was observed to be on the 13. day of *March*. And in our time. it is come to the 11. and 10. of the same month. So that in the space of 1020. yeares, or thereabout, the Equinoctiall points are gotten forward no lesse then 14. dayes. The time of the Solstice also about 388. yeares before *Christ*, was observed by *Meton* and *Euclimachus* to fall upon the 18. day of *June*: as *Joseph Scaliger*, and *Jacobus Christmannus* have observed. But the same in our time, is found to be on the 12. of the same month.

The

The Co-
lures.

The Ecliptick and *Æquator* are crossed by two great circles also, which are call'd *Colures*, both which are drawn through the Poles of the world, and cut the *Æquator* at right Angles. The one of them passing thorough the pointes of both the Intersections; and is called the *Equinoctiall Colure*: The other passing through the points of the greatest distance of the *Zodiack* from the *Æquator* is therefore called the *Solstitiall Colure*.

PONT. The office of the *Colures* in general is. First to show the foure principall points of the *Zodiack*, in which, by reason of the motion of the Sun, there are caused the great changes of the Seasons of the year. Of which points, two are in the *Æquator*, at *Aries* and *Libra*, determining the place of the *Equinoctial Colure*: and *Capricorn*, which constitute the *Solstitiall Colure*. Secondly, To distinguish the *Æquator* *Zodiack*, and the whole Sphere of the Heavens into foure equall parts, the use of which is principally seen in examining the ascensions of the Signes. These *Colures* differ from each other, in that the *Solstitiall Colure* passeth through the Poles of the world, and also of the *Zodiack*; but the *Equinoctiall Colure* passeth through the Poles of the world only.

Now that both the *Colures*, as also the *Equinoctiall* points have left the places, where they were anciently found to bee in the heavens, is a matter agreed upon, by all those that have applyed themselves to the observa-
tion

tions of the Cœlestiall motions: onely the doubt is, whether fixed Starrs have gone forward unto the proceeding Signes, as Ptolomy would have it: or else whether the Equinoctiall and Solsticiall points have gone backward to the subsequent Signes, according to the Series of the Zudiack, as Copernicus opinion is.

PONT. *What the opinion of Joseph Scaliger was, concerning the proceſſion of Equinoctial points thus diversly thought on by Ptolomy and Copernicus, you have expressed in an epistle of his to Isaac Casaubon, there having been not long before a disputation holden concerning some certain Mathematicall question, at the intreaty of some of the chiefest of the States of the Low Countries; among which number Scaliger was chosen also, as an Arbitrator: which Epistle of his, was afterwards Printed, amongst some other of his Epistles at Paris. What the Illustrious Tycho also thought concerning this point, you have in his Progymnasmata Instaur. Astron. p. 255. But I will first set down Scaliger's opinion: and afterward adde Tycho's, and some others also. Scaliger speaks thus.*

Alteræ literæ tuæ, &c. I received (saith he) your second letters, the next day after your former. In which you make mention of one that undertakes to discourse of the Magneticall direction of the Needle. Many indeed have endeavoured in this matter, and doe daily endeavour, being thereto encouraged by the rewards proposed by the Illustrious States. To whose hands some have delivered

lowered up their opinions in writing: and Astronomers forthwith have been called about it. In which number, it was my chance to be chosen for one: there being indeed amongst them many excellent, both Mathematicians and Mathematicians. But those that professed the Mathematick, were altogether unexperienced in Nauticall affaires: and the Navigators were as ignorant of Astronomickall. Besides these Authors of whom wee were to passe our judgments, performed nothing worth great expectation. Neither hath that Englishman, who wrote a Book three yeares since, of the Magnet, produced anything answerable to the great opinion was raised of it. I my selfe have often proposed, to these Mathematicians that professe in this place, a thing which it seemes can never sinke into their heads: insomuch that they entertained it with scorne and laughter. Hipparchus was the first that brought in that merry conceit of the eight spheres moveing toward the East: and so perswaded Ptolomy, that the fixt Stars in the eighth sphere moved all in the same order, situation, and distance from each other, upward the East. Which Ptolomy so confirmed, that it had been a hainous matter for posterity to have doubted of the same. And first of all within the memory of our Fathers, Nicolaus Copernicus, that great restorer of Astronomy, perceived the weaknesse of this conceit of Hipparchus: and withall observed, that the eight Sphere did not move toward the East, but that the Equinoctiall points went forward in o the precedent signes: and this he calls *agonysis* *transpositio*

But this observation of his, bee onely nakedly proposed, without any demonstration at all. But I have observed, that the Starrs have not (as Hipparehus and Ptolomy dreame) gone on to the subsequent parts: and that the Cynosure, or Polar Star was at the same distance from Pole in Eudoxus his time, as it is at this day. For proof of which assertion I have collected many instances. which being granted, the procession of the Æquinoctiall point must necessarily follow. For one of these two must needs be granted; to wit, either of the motion of the eighth Sphere towards the east, or else the progresse of the Æquinoctiall points into the precedent Signes. Now that the first is not to be admitted appears manifestly, because that the fixed Starrs have not at all changed their situation in respect of the Pole, since Eudoxus his time. Therefore the other must needs be granted. The Æquinoctiall points therefore, have gone forward to the antecedent Signes. Which proposition notwithstanding the great Copernicus had no way to demonstrate, but out of the Phænomena; by which that other motion might as well bee defended, as this. Wee therefore now have this equivocalis iniquis. But what is it? Even nothing else, but the motion of the Æquinoctiall points into the precedent Signes. Now if the Æquinoctiall points bee moveable; and the Æquinoctiall Circle bee described by these points; the Æquinoctiall Circle then must needs be moveable also: which is as true, as truth it selfe. And if the Æquinoctiall circle be moveable; his Pole must be moveable also: and

so the Poles of the Equinoctiall must be drawn from the Poles of the world. for the Pole of the World is immovable; but this moveable. Besides, all the Meridian circles do passe through the Poles of the Equinoctiall: and in the superficies of some Dials, the Meridian line, which is drawn for the placing of the Sun Diall, is understood to passe through the Poles of the Equinoctiall; which is confessed by all men, and is most true. But because the Poles of the Equinoctiall are moveable, the Meridian line, that passeth through the same, must be moveable also. And therefore it necessarily followeth, that after some certain number of yeares, there wil be no further use of these Meridian lines in the designing of the hours in Dials; but a new Meridian line must be taken, and the situation of the Diall altered, though not the Diall it self. We may therefore conclude, that the Sun Dials, after some certain time, will prove false, unless the Meridian line be rectified. This is demonstrated of the very principles of the Mathematicks. But besides this, we have some notable instances out of the Ancients, which do manifestly evince, that after some tearm of yeares, Sun Dials doe not agree to their first designations: all which I have diligently collected. These things thus demonstrated, I proposed them to these Mathematicians, that, because the whole busineses of the Magneticall Needle had dependance upon these Meridians, they would consider, whether or no, this doctrine, by me first proposed, might open the way to the matter in hand, &c.

Thus far Scaliger. Let us now hear Tycho. Inæqualitatis, inquit, circa motum, &c. That the reason (saith he) of the inequality observed in the motion of the fixed Starrs, or as Copernicus calls it, the Anticipation of the Equinoctiall points (which is a very subtile and ingenious speculation of his owne, that so he might reconcile and maintain the inventions of all that went before him) that this conceit, I say, doth not consistere tibi, these 70. yeares observations of the Starr called Spica Virginis, since his first observing the same, doe manifestly prove. For in this space of time, the Recipro- cation of the Equinoctiall points, or promotion of the Starrs, is swifter, by much, then he conceived it would have been. So that, whereas now they ought to have finished but one degree in an hundred years space, or thereabouts, they finished the same in 70. the quantity of the yeares being not so slow as hee imagined it to be: as appears plainly by that wee have delivered in the former Chapter. For these two things do mutually cohere together in Copernicus, that when the quantity of the yeare is greatest, the motion of the fixed Starrs should then bee slowest. But these things the accurate observations of these presents yeares doe manifestly elude, for as much as they doe not answer his periodicall re- stitutions.

Thus these two great lights of our times, Tycho, and Scaliger, to whom wee may adde the opinion of our Country-man Dr. Gilbert, who in his 6th book de Magnete, will have the preces- sion of the Equinoctiall points to depend upon the

Magneticall motion of the Poles of the Earth. And this is that English-man, as far as I can gather, whom Scaliger mentions in his fore-cited Epistle Vnto whom I refer you for satisfaction in this point, in his lib. 6. cap. 8.

The first Star of *Aries*, which in the time of *Meton the Athenian*, was in the very Vernall Intersection, in the time of *Thales Miletus* was two degrees before the Intersection. The same in *Timosthenes* his time, was behind it two degrees 24. minutes: in *Hipparchus* time, 4. degrees, 40. minutes: in *Albunafars* time, 17. degrees, 50. minutes: in *Albarenus* his time, 18. degrees, 10 minutes: in *Arzachel* time, 19. degrees, 37. minutes: in *Alphonsus* his time, 23. degrees, 48. minutes: in *Copernicus* and *Rhaeticus* his time 27. degrees, 21. minutes. Whence *Franciscus Baroccus* is convinced of manifest error, in that he affirms that the first Star of *Aries*, at the time of our Saviours Nativity, was in the very Vernall intersection: especially contending to prove it, as he doth, out of *Ptolemies* observations, out of which it plainly appeares, that it was behind it no lesse then 5. degrees.

In like manner the places of the Solstices are also changed, as being alwayes equally distant from the *Æquinoctiall* points. This motion is finished upon the Poles of the *Ecliptick*, as is agreed upon, both by *Hipparchus* and *Ptolomy*, and all the rest that have come after them. Which is the reason that the

the fixed Starrs have alwayes kept the same latitude, though they have changed their declination. For confirmation whereof, many testimonies may be brought out of *Ptolomy*, lib 7. cap. 3. *Almag.* I will onely allidge one, more notable then the rest, out of *Petolomies* *Georg.* lib. 1. cap. 7. The Starr which wee call the *Polar Starr*, and is the last in the taile of the Beare, is certainly known in our time to be scarce three degrees distant from the Pole: which very Starr, in *Hipparchus* his time, was above 12. degrees distant from the Pole: as *Merinus* in *Ptolomy* affirms. I will produce the whole passage, which is thus. *In the Torrid Zone, (saith hee) the whole Zodiack passeth over it, and therefore the shadows are cast both wayes, and all Starrs there are seento rise and set. Onely the little Beare begins to appear above the Horixon in those places, that are 50 furlongs Northward from Ocele.* For the Parallel that passeth through *Ocele* is distant from the *Æquator* 11. gra. 3. And *Hipparchus* affirms, that the Starr in the end of the little Beares taile, which is the most Southward of that Constellation, is distant from the Pole 12. degrees, 3. This excellent testimony of his, the Interpreters have, in their translating the place, most strangely corrupted (as both *Johannes Wernerus*, and after him *Peter Nonius* have observed) setting down in stead of 500. *Quinque mille*, 5000. and for *Australissimam*, the most Southern, *Borealissimam*, the most Norther-

ly : being led into this error, perhaps, because that this Starr is indeed in our time the most Northern. But if these testimonies of *Marinus* and *Ptolomy* in this point bee substrahed, *Strabo* in his *lib. 2. Geogr.* shall acquit them of this crime. And hee writes thus. It is affirmed by *Hipparchus* (saith he) that those that inhabit under the Parallel that runneth through the Countrey called *Cinnamomifera* (which is distant from *Meroë* Southward, 3000. furlongs, and from the Æquinoctiall, 8800.) are situated almost in the middle, betwixt the Æquator and the Summer, Tropick, which passeth through *Syene* (which is distant from *Meroë* 5000. Furlongs) And those that dwell here, are the first that have the Constellation of the little Bear, inclosed within their Arctick Circle, so that it never sets with them: for the bright Starr, that is seen in the end of the taile (which is also the most Southward of all) is so placed in the very Circle it self, that it doth touch the Horizon. This is the testimony of *Strabo*, which is the very same that *Ptolomy* and *Marinus* affirme; saving that both in this place, and elsewhere, he always assignes 700. Furlongs in the Earth, to a degree in the Heavens, according to the doctrine of *Eratosthenes*: whereas both *Marinus* and *Ptolomy* allow but 500. onely: of which wee shall speak more hereafter.

Let us now come to the lesser Circle which

which are described in the Globe. And these are all Parallel to the *Æquator*: as first of all the *Tropicks*, which are Circles drawn through the points of the greatest declination of the *Ecliptick*, on each side of the *Æquator*. Of which, that which lookes toward the North Pole, is called the *Tropicke of Cancer*: and the other, bordering on the South, the *Tropicke of Capricorne*. For the Sun, in his yearly motion through the *Ecliptick*, arriving at these points, at his utmost bounds, returneth again toward the *Æquator*. This Retrocession is called by the *Greekes* *πώλη*, and the Parallel Circles, drawn through the same points, are likewise called *Tropickes*. *The Tropick*

PONT. *The use of those tropickes is, First, to shew when the Sun, in an oblique Sphere, is nearest the verticall point of any place, and so likewise when the farthest off. Secondly, they shew, when the Sun, in his Diurnall motion, maketh the longest or shortest dayes in the yeare. Thirdly, they are, as it were, the limits and bounds, wherein the Sun finisheth his yearly course. Fourthly, they distinguish the Torrid Zone in the heavens, from the two temperate Zones.*

The distance of the *Tropicks* from the *Æquator*, is diversly altered, as it may plainly appear, by comparing the observations of later times, with those of the Ancients. For, not to speak any thing of *Strabo*, *Proclus*, and *Leontius Mechanicus*,

who all assigned the distance of either Tropicke from the Æquator to bee 24. degrees (for these seeme to have handled the matter but carelesly) we may observe the same from the more accurate observations of the greatest Artists. For *Ptolomy* found the distance of either Tropicke to be 23. gr. 51. min. and $\frac{1}{2}$. just as great, as *Eratosthenes* and *Hipparchus* had found it before him: and therefore he conceived it to be immutable. *Machometes Aratenfis* observed this distan to bee 23. degrees, 35. minutes, right as *Almamun* King of Arabia had done before him. *Arzabil* the Spaniard found it to be in his time, 23. degees, 34. minutes. *Almchon* the Son of *Albumasar*, 23 degrees, 33. minutes, and halfe a mipute. *Prophatius* a Jew, 23. degrees, 32. minutes, *Purbachius* and *Regiomontanus*, 25. degrees, 28. minutes *Johan. Wernerus*, 23. degrees, and 28. minutes, and an half: and *Copernicus* found it in his time to be just as much.

PONT. This distance of the Tropickes from the Æquator, is caused by the Suns greatest declination, as the Astronomers call it. which greatest declination of the Sun hath been, at divers times, found to be variable. For begining as far backward, as possibly we can, and so driving it down by the Olympiads, and the yeare of Chritt, even to these present times, according to *Tychoes* calculation. we find it to bee thus, both in the degree and minute, as is here expressed in this ensuing Table.

Aratus

	gr. m. 11.	
Aratus	24. 0. 0.	Olympiad.
Hipparchus	{ 23. 51. 1.	{ 124.
Erastosthenes	{	{ 127.
Ptolomeus	23. 51. 20.	An Christi 140.
Albategnius	23. 35. 0.	749.
Arzachel	23. 34. 0.	1070.
Almeon	23. 33. 1.	1140.
Prophatius Judæus	23. 32. 0	1300.
Purbachius	23. 29. 30.	1458.
Regiomontanus	23. 30. 0.	1490.
Copernicus	23. 38. 30.	1500.
Tycho Brahe	23. 31. 5.	1592.

To which we may adde these words out of Tychoes. 1. Book of new Star which appeared An. 1572. p. 101. where he saith, that by certain observations it hath been found, that both the Suns greatest declination, as also the other Intermediat by the same reason are alter'd, as it is testified by the whole current of the most skilfull Artists, in a continuall succession of time: so that Ptolomies time, & some certain yeares before him, it was found to be 23. gr. 51. 1. but it doth not appear by any certain testimony to have been ever greater. Whence may be collected, that Aratus, whome we have set in the first place, who assigns 24. gr. speaks with the largest, and as it were, at randome, and (as our learned Author hath also observed of Strabo, Proclus and Leontius Mechanicus) not so accurately as he should have.

There are also two other lesser circles described in an equall distance from the Poles, to that of the Tropickes from the Æquator?
which

The Arctique, and Antartique circles.

which circles take their denomination from the Pole on which they border. So that one of them is called the *Arctick* or North circle, and the opposite circle the *Antarctick* or Southerne. In these circles the Poles of the Ecliptique are fixed, the Solstitiall Colure crossing them in the same place. *Strabo, Proclus, Cleomedes*, all Greek Authors, and some of the Latines also, assigne no certain distance to these circles from the Poles: but make them various and mutable, according to the diversity of elevation of the Pole, or diverse position of the Sphære: so that one of them must be conceived to be described round about that Pole which is elevated, and to touch the very Horizon, and is therefore the greatest of all the Parallels that are alwayes in sight: and the other must be imagined, as drawn in an equall distance from the opposite Pole; and this is the greatest of those Parallels that are alwaies hidden.

PONT. *The Arctique, and Antartique circles do shew, 1. The Poles of the Zodiacke and their distance from the Poles of the world, 2. They do distinguish the frigid Zones from the Temperate, and with the Tropiques and Equator they helpe to divide the whole Heaven into five parts, or regions which they call Zones.*

Besides these circles expressed in the *Globe*, there are also some certain other circles in familiar use with the Practicall Astronomers, which they call *Verticall* circles. These are greater circles drawn from the *Verticall* point through

The Verticall circles.

through the Horizon, in what number you please: and they are called by the *Arabians Azimuth*, which appellation is also in common use among our ordinary Astronomers. The office of these circles is supplied by the help of a Quadrant of Altitude, which is a thin plate of brass divided into 90. degrees. This Quadrant must be applied to the *vertex* of any place, when you desire to use it, so that the lowest end of it, noted with the number of 90. may just touch the Horizon in every place. This Quadrant is made moveable, that so it may be fastened to the verticall point of any place.

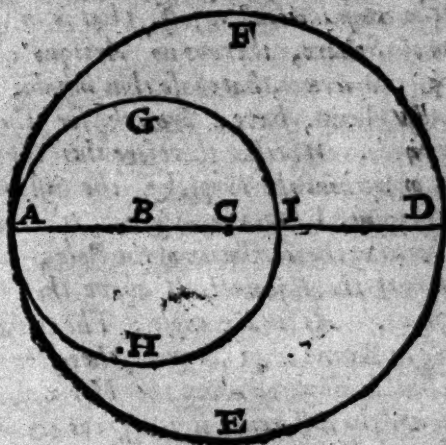
PONT. Concerning the moveableness or immovability of the *Arctique*, and *Antarctique* Circles, Joseph Scaliger reports himself to be the first that observed it, out of the *Ancient Greek Authors*: as you may see in his *Commentaries upon Manilius*, revised, and published by himself a little before his death. Neither doth he think that any *ancient Latine Author* within 400. yeares after those *Greek Writers*, nor scarcely any before *Sacroboſco's* time, can be found to have determined them to be immovable. But because there are many excellent things to be met withall in that passage of his, and that he sets down the same by way of demonstration, I have thought it not impertinent, seeing our Author hath given a touch at it, to set down Scaliger's opinion in his own words: as you have them upon those verses of *Manilius*, lib. 1. *Astron.*

Circulus ad Boreā fulgentem sustinet Arcton,
Sexque fugit solldas a cœli vertice partes.

He

He proceeds after this manner. Describamus circuli Equinoctiali paralleli XC &c. Let there be described (saith he) 90. Parallel circles to the Equinoctial, and these will be the same that Geminus calles, ἀνεωπῆς, alwayes appearing. Now among all those, That which toucheth the Horizon in the point of intersection of the Horizon and Meridian, will be. πύσις ὁ τῶν ἀνεωπῆς, the greatest of those that alwayes appears, and so consequently, the Arctique Circle of that place: now because the Horizons are moveable, the Arctique Circles must also be moveable. So in the Climat wherein Cnidus lies, the elevation of the Pole being thirty six degrees, Eudoxus determines the Arctique Circle also to be so many degrees from the Pole: in like manner in another Climate, it will bee diverse, according to the diversity of the elevation of the Pole. Thus Hipparchus ἰσὶς ἀδύνας παύσασθαι κίναθ' ἀνέχου ἀπὸ τοῦ πόλου περιμειράς λ'. ἀπὸ δ' ἐν πόλῳ οὐ μείρας δε. At Athens (saith he) the greatest of the Circle alwaies appearing is distant from the Pole thirty seven degrees: but that in Rhodes thirty six degrees: and looke how great the Altitude of the place is, the same must the distance necessarily be, betwixt the Pole and that point, by which the Arctique circle is described. And therefore the Ancient Greekes alwayes defined the Arctique circle to be τὸ ἀρκτικὸν τῶλον ἐν μείον τοῦ πόλου. Στοι τὸ ἀρκτικὸν τῶλον τῆς διήνορος ἐν μείον. The most Northerne point that their Horizon, or place of habitation had. So that the Arctique circle is nothing else, but the points of their habitation which touch-

with the Horizon. For in describing, they have both one common point. Only in this they differ, that the center of the Arctique circle is the Pole of the world; but the center of the Horizon is the Vertical circle, or Zenith of the place,



As for example. A. F. D. E. is the Horizon: A. G. C. H. the Arctique circle A. D. the Meridian: A. the point of Intersection of the Horizon with the Meridian; in which place also the Arctique and Horizon in describing doe mutually touch each other. B. the Pole: C. the Zenith of the place, I. the opposite point of the diameter of the Arctique circle, Now if the elevation of the Pole bee full 45. degrees, as it is at Vienna in France, then the point I. will be the same with C that is to say, the opposite part of the Arctique circle will touch the Zenith of the place. But if the elevation of the Pole be lesse then 45. degrees;

degrees, the Zenith will then fall without the circle: but if it be greater, it will fall within. That by this meanes it will come to passe, that the nearer we are to the Equator, the lesser the circles will bee: and contrarywise, the farther we live off the Equator, the greater they are: In under the Equinoctiall it self, that is in a right position of Sphere, there is no Arctique circle at all: Pytheas writes, that those that inhabite Thule, now call Iſeland, have a Tropick for their Arctique circle. Whether therefore this Circle fall within or without the Tropicke, the distance of it from the point, 1. Will be as great, as is the difference betwixt the elevation of the Pole, and the elevation of the Equinoctiall above the Horizon of the place. As for Example: The elevation of the Pole at Rome is 41. degrees, therefore the Equinoctiall is elevated above the Horizon 48. gr. 20. m. and the difference is 7. degrees 40. m. And therefore the Zenith, or verticall point of Rome, falleth 7. degrees, 40. m. without the circumference of its Arcticke circle. So this distance which those that inhabite Iſeland, is 43. gr. as having their Pole elevated 66. degrees 30. m. So that the Tropick with them toucheth the very point of intersection of the Meridian and Horizon. And therefore, Martiane Cappella designs the Arctick circle to be, *Semper apparet, & contingens confinia Finitoris, nunquam merſus aſurgens*. A circle that alwayes appeareth, and toucheth upon the skirts of the Horizon, yet never goes under it. By these words *Confinia Finitoris*, he meaneth the intersection of the Horizon and Meridian,

Meridian to equino λ μ ν τ θ , in the most Northerly point.

These grounds being thus laid, we see that as many habitations as there are, so many Arctick circles there are also, and the same not quarellous, fixed and unchangeable, but different according to the diversity of places. So that, by this we may plainly perceive the error of our moderne Artificers, who, in their Artificiall Globes, describe this circle contrary to the doctrine and practise of the Ancients, drawing it on the Poles of the Ecliptique above the Pole of the world. For such an Arctick circle there cannot be, but only to those that inhabit Syene by the Nile: for with them, the Pole is elevated 23. gr. 30. m. These things considered, the Arctick circle ought not to have any place in the Materiall Globe, unlesse it be made for the inclination of some certain place: otherwise there can be no such Arcticke circle.

These things, when I first proposed in Aquitaine, where were many, both learned and unlearned, Noble and Padants, it cannot be imagined with what scorne and hissing they entertained them. And at length, when my constancy would not give place to their stubborne ignorance; I thought I should have been beaten among them. Yet at last, having nothing to defend themselves with, they said, that, however it were, these circles were usefull for the distinction of the Zones. At which answere of theirs, I had much adoe to forbearo laughing. For this division of the world into Zones, is quite cashiered in these our times, when as the whole world hath at length been fully discover-
red

red by the Navigations of the Portugals and Spaniards. And for this purpose, to confute the Mathematicians, I alledged these words of Strabo, ἡ δὲ Πολύβιος ἐν τῷ τῷ πρῶτῳ βιβλίῳ τῶν ἀρχαίων διπορομένων, δύο μὲν τὰς ἐκ τῶν ἀστέρων, δύο δὲ τὰς ἐκ τῶν τροπικῶν ἐκ τῶν ἀστέρων, καὶ πάλιν ἐκ τῶν τροπικῶν τὰ ἀστέρων. Polybus therefore did not, (saith he) making certain Zones, which are to be limited by the Arcticke circles: two of which line under the said Arctiques, and other terminated betwixt the Arctiques, and the Tropiques. For this is a Maxime: That determinate things cannot be bound by uncertain and indeterminate limits. This their Philosophy therefore is vaine and frivolous. But yet their impudence ends not so. For you shall hardly meet with any of those Mathematicians, that will not presently conclude him madd, that should but dare to descend any whit from the doctrine of John de Sacrobosco, in the point of these circles. Yet one of them, not long since, being as it seems, advised thereto by the former edition of Manilius, confesseth by the way, and as it were unwillingly, that the Ancients made other use of the Arcticke circles, then we now doe. And yet he would not be thought to have learned this of me: notwithstanding these kind of fellows are the most ignorant in matters of Antiquity, in the world. Who should be the first broker of this ridiculous conceit, I cannot guesse, otherwise, then that it must needs bee some latine Writer, and that 400. yeares later then any of the Greeke Authors, And I know not whether

any other taught this doctrine before John de Sacrobosco: certainly he is the most ancient I can readily think on. As therefore our men are in an error, in making the Arctique to bee an Immoveable circle, so likewise are the Ancients, and those among us that follow them, to be blamed, for making this circle to be Parallel to the other three: whereas the Parallel circles in a Sphere have the same Pole with the Sphere it self. But the Pole of the Arctique is the same alwayes with the Pole of the World: whereas the Pole of the other three altereth, as do the Tropicall, and Equinoctiall points. For the Equinoctiall and Tropicall points doe anticipate their places in the Zodiack: insomuch, that in a certain tearme of yeares, they are removed forward a degree. Now the Equinoctiall, and Tropicall circles, are no other then what are described by those points, which in themselves are moveable. Therefore are their Poles also moveable. But wee shall suffer for these things too, I doubt not, untill that length of time shall have beaten this into the heads of such men, with whom strength of reason is able to prevaile nothing at all.

And this is the opinion of Scaliger, and the Ancients, concerning the Arctique circles: which Johannes Pincierus, a learned man, in his lib. 2. cap. 13. Parergory Olij Marburg. hath lately examined, and indeavoured to confute the Arctique circle (saith he) is thus described by Proclus. Arcticus circulus, &c. The Arctique circle is the greatest of all those circles that are alwayes in sight, and it toucheth the Horizon in

one point, and is seen also above the earth. And the Antartique he defines thus. The Antartique is a circle equall and Parallel to the Arctique, and but wholly hid under the earth. These circles therefore, in the opinion of Proclus, are moveable, and are described by a point that toucheth the Horizon about the Pole that is nearest to it: and they are also changed, with the Horizon, as often as a man moveth either Northward or Southward. So that the nearer they are to the Pole, the lesser they are: and so contrariwise, the farther off they are from the same, the more they are so much the greater: and consequently it followes, because they have no fixed place, that therefore they cannot be described upon a Sphere or Globe.

But from hence there ariseth three inconveniences. First, that these Arctiques described by Proclus, are not of any use in distinguishing the Frigid Zone from the Temperate, by reason of their uncertain situation, and mutability. The next is, that with those that inhabite within twenty three degrees and an halfe of the Pole, (which is as much as the Suns greatest declination from the Æquator) the Arctique circle will bee the same with the Tropique of Cancer, and the Antartique with that of Capricorne. So that they will have but two lesser circles or Parallels, which will make but three Zones in all, two cold ones, and a torrid. For in this confusion of the circles, there will be no distinction betwixt the cold, and the temperate Zones. And which is more, they that dwell under the Æquator. will have

no Arctiques at all. Lastly there are certain accidents proper to, certain Climates, which cannot be assigned them, unlesse there bee fixed and certain lines for to distinguish the cold Zones from the temperate.

As for example, If it be enquired, what properties are incident to those that inhabite betwixt the Tropique of Cancer and the Arctique circle: and what to those under the Arctique circle is self: and lastly, what betwixt the Arctique circle and the Pole of the World. To these questions there can be no answer made without these fixed Arctique circles. Besides this, it would take away much light and futherance, both from Geographicall Maps, and Astronomicall instruments; if these Arctique circles might not bee described in them: which could not possibly bee described in them, but that they might change evermore with the Horizon.

These and the like inconveniences are easily avoided, by placing the Arctique circle, as usually it is, on the Poles of the Zodiaque. Neither am I any way swayed with the Authority of Joseph Scaliger, adhering to Proclus his Doctrine of the mutability of the Arctique Circle: although I am not ignorant, how rare a thing it is, for such Judgment, matched with so great knowledg, to fall into an error. And as for that testimony which they bring out of Strabo, lib. 2. Geogr. that it is sufficient, if there be Arctique circles in the temperate Climates, and that those that have any,

have not all the same: this is idle repetition
(so use Straboea own words) nothing to the argu-
ment in hand, and concludes nothing. For then they
should be of no use at all. I cannot therefore assent
to a man, whose Tenent is dissonant both from the
nature of the thing, and reason it self.

But to return at length to Proclus: who, seeing that he acknowledgeth that there are five Zones: two of which are terminated betwixt the Poles, and the Arcticque and the Antarctic circles: and other two bordering upon the same, which are the two temperate Zones, and are bounded on one side by the Arcticque, and the other, by the Tropickes: betwixt both which lieth the Torrid Zone. he himself seems tacitely to approve these Immoveable Arcticques, without which there can be no set constant limits of the Frigid and temperate Zones.

Thus Scaliger and Pincierus. Now concerning the opinion that the Ancientes had of these Zones, namely, that some of them were inhabited through extreame cold, and some through parching heat; notwithstanding these are discovered at length to be but vaine dreames, by the late Sea-voyages both of the Portugals and our owne Countrymen: yet can it not be denyed, but that in each of them there are certain speciall and peculiar Occurrences. So that, if, but for doctrine sake. it were good that these circles should not bee taken away, neither are wee to despise it, if by the industry of later times, any thing hath been added to the inventions of the Ancients, which may any whit bee usefull for the instruction

instruction of learners; or may any way conduce to
the clearing of things in themselves obscure and in-
tricate.

C H A P. III.

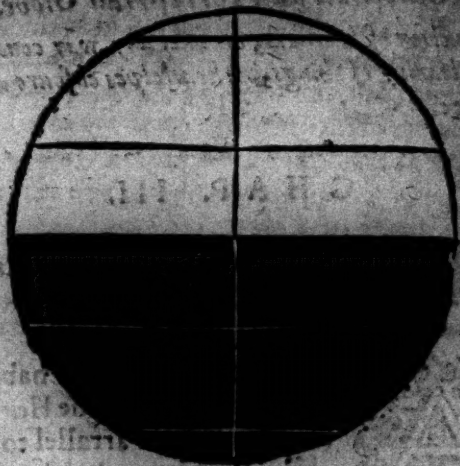
Of the three Positions of Spheres: Right,
Parallel, and Oblique.



According to the diverse habitude
of the Equator to the Horizon,
(which is either Parrallel to it, or
else cutteth it, and that either
in Oblique, or else in Right
Angles,) there is a threefold
Position or situation of Spheres. The first is of
those, that have their Pole for their Verticall
point: for with these, the Equator and Hori-
zon are Parallel to each other, or indeed ra-
ther but one circle betwixt them both. The 2^d
is of those whose Zenith is under the Equator.
The third agreeth to all other places else. The
first of these situations is called, a Parallel
Sphere: the second a Right: and the third an
Oblique Sphere. Of these severall kinds of po-
sition, the two first are simple: but the third is
manifold and diverse, according to the diver-
sity of latitude of places. Each of these have
their peculiar properties.

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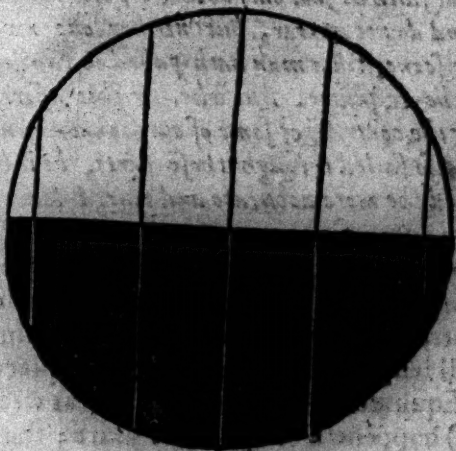
Those



Those that inhabite in a Parallel Sphere, see not the Sun or other Starr, either rising or setting, or higher or lower, in the diurnall revolution. Besides, seeing that the Sun in his yearly motion traverseth the whole Zodiaque, which is divided by the Æquator into 2. equall parts: one whereof lieth toward the North, and the other toward the South: by this means it comes to passe, that while the Sun is in his course through those signes that are nearest their verticall Pole, all this while hee never setteth, and so maketh but one continued Artificiall day; which is about the space of six months. And so contrarywise, while he runneth over the other remoter signes, lying toward the opposite Pole, hee maketh a long continuall night of the like space of time, or thereabout. Now at such time as the Sun in his diurnall revolution shall come to touch the
very

very Equator, he is carried about in such sort, as that hee is not wholly apparent above the Horizon, nor yet wholly hiddeu under it: but as it were, halfe cut off.

The affections of a Right Sphere are these. All the Stars are observed to rise and set in an equall space of time: and continue as long above the Horizon, as they doe under it. So that the day and night is alwaies here of equal length.

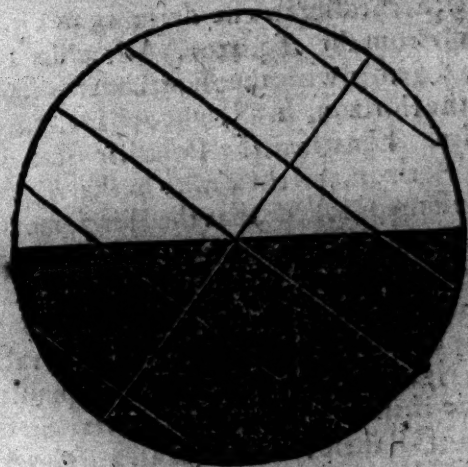


PONT. That in a right Sphere all the Stars do both rise and set, that is, are a'l generally seen above the Horizon, and in like manner doe also all set by turnes; so likewise that boath the Poles, both Arctique and Antarctique may be seen at once: hath hitherto been the received opinion both of Geminus, and Proclus, and generally, of all other Writers; which our Author also here followeth.

Yet if wee do but examine the matter more narrowly, we shall find this to agree not so much with the Sensible, as with the Rationall or Intelligible Maxime. For as much as even in a Right Sphere, the sight can hardly reach both the Poles, by reason of the exuberancy of the earth. Which is also confirmed by the Testimony of Johannes Lerus a Burgonius, who in his history of his voyage into the New world, wethers thus. Non modo sub Aequinoctiall polus uterque non apparet, &c. Under the Aequinoctiall (saith he) not only both the Poles are invisible, and do not appear, but neither one nor other can be seene, till a man hath passed on two degrees from the Equator. But whether this assertion of his, or the contrary of some of our Countrymen, who have also sailed through those parts, be so be accounted the more accurate and true, I leave to other to determine.

An Oblique Sphere hath these properties. Their dayes are sometimes longer then the Nights, some times shorter, and sometimes of equall length. For when the Sun is placed in the Aequinoctiall points, which (as wee have said) happeneth twice in the yeare; the daies and nightes are then equall. But as hee draweth nearer to the elevated Pole, the dayes are observed to increase, and the nights to decrease; till such time as hee comes to the Tropique, when as he there maketh the longest dayes and the shortest nights in the yeare. But when he returneth toward the Opposite Pole, the dayes then decrease, till he toucheth the Tropique, that lieth nearest the same Pole:

and the dayes shortest. In this position of
 Sphere also, some Starrs are never seen to set;
 such as are all those that lie within the com-
 passe of a Circle described about the Elevated
 Pole, and touching the Horizon: and some in
 like manner, are never observed to appeare a-
 bove the Horizon: and these are all such
 Starrs as are circumscribed within the
 like circle drawn about the Opposite Pole.



These Parallel circles (as wee have said) are
 those which the Greeks, and some of the La-
 tines also, call the Arcticque and Antarcticque
 circles, the one alwaies appearing, and the o-
 ther alwaies lying hid. All the other Starrs,
 which are not comprehended within these
 two circles, have their riseings and settings by
 course. Of which those that are placed be-
 tween

between the *Æquator* and this alwayes apparent circles, continue a longer space in the upper Hemisphere, and a lesse while in the lower. So on the contrary, those that are nearer to the Opposite circle, are longer under the Horizon, and the lesse while above it. Of all which affections this is the Cause. The Sun being placed in the *Æquator*, (or any other Starr) in his daily revolution describeth the *Æquinoctiall* circle: but being without the *Æquator*, he describeth a greater, or lesser Parallel, according to the diversity of his declination from the *Æquator*. All which Parallels, together with the *Æquator* it self, are cut by the Horizon, in a Right Sphere, to right angles. For when the Poles lie both in the very Horizon, and the *Zenith* in the *Æquator*: it must needs follow, that the Horizon must cut the *Æquator* in right angles, because it passeth through its Poles. Now because it cutteth the *Æquator* at right angles; it must also necessarily cut all other circles, that are Parallel to it, in right angles: and therefore it must needs divide them into two equall parts. So that if halfe of all these Parallels, as also of the *Æquator*, be above the Horizon, and the other halfe lyeth under it; it must necessarily follow, that the Sun and other Starrs must bee as long in passing through the upper Hemisphere, as though the lower. And so the daies must be as long as the nights, as all the Stars in like manner will be 12. hours above the Horizon, and as many under it. But in an Oblique

lique Sphære, because one of the Poles is elevated above the Horizon, and the other is depressed under it: all things happen cleane otherwise. For seeing that the Horizon doth not passe through the Poles of the Æquator; it will not therefore cut the Parllaels in the same manner, as it doth the Æquator: but those Parallels that are nearest to the elevated Pole, will have the greatest portion of them above the Horizon, and the least under. But those that are nearest the opposite Pole, will have the least part of them seen, and the greatest part hid; only the Æquator is still divided into two equall parts, so that the conspicuous part is equall to that which is not seen. And hence it is, that in all kinds of Obliquitie of Sphære, when the Sun is in the Æquator, the day and night is alwayes of equal length. And as he approacheth toward the elevated Pole, the days encrease; because the greater Arch, or portion of the Parrallels are seen. But when he is nearer the hidden Pole, the nights are then the longest, because the greatest segment of those Parallels are under the Horizon. And by how much the higher, either Pole is elevated above the Horizon of any place, by so much, the daies are the longer in Summer, and the nights in Winter.

PON T. *The position or situation of a Sphere is rightly distinguished by our Author, into three kinds, to wit, Parallel, Right, and Oblique. Notwithstanding Clavius, with Sacrobosco. acknowledged only two: and they are, Right, and Oblique.*

lique. For if it be demanded, (saith Clavius) what manner of Sphere they may be said to have, that inhabite under the Poles: we must make answer, an Oblique. But both Clavius, and Sacrobosco are herein deceived. For those that have such a position of Sphere, as that they dwell under the Pole, the Equator with them doth not make Oblique Angles with the Horizon: because the Horizon and Equator there, make both but one circle. This kind of Sphere therefore may more rightly be called a Parallel, or Neutrall Sphere: because that it's Verticall point falleth upon the Pole of the Sphere. But Joseph Scaliger hath given it the aptest appellation of all, in his Notes, upon Manilius. Astronom. lib. 3. upon these Verses.

Stantis erit cœli species, laterumque meatus
Turbinis in morem rectâ vertigine currit.

Where he saith, that every Sphere may be said, aut jacere, sedere, aut stare, either to lye, sit, or stand. So that the first position of Sphere is, as of lying all along, which is that of a Right Sphere, where the Horizon makes right Angles with the Equinoctiall. The second is of sitting, τῆς ἰστάμενης. The third is of standing, τῆς μολομένης and is like a Mill. for in this Position, the Equinoctiall, supplying the office of the Horizon, and as it were, turned round about, is just like a Hand-mill, both in both it, and manner of turning about, But we cannot so properly call it a Right Sphere because of the right Angles that it makes with the Equinoctiall, as passing through it's Poles: because that that appellation seems to suit more fitly

fully with a standing Sphere, in which the Equinoctiall is the same with the Horizon and Arctique circle. Lastly there is but one Right, or Lying Sphere because there is but one Equinoctiall: and there are but two standing Spheres; because there be but two Poles. But there is great variety and diversities of Oblique; or sitting Spheres, as may manifestly appear to any man; and as our Author hath declared at large,

CHAP. III.

Of the Zones.

THe four lesser Circles, which are Parallel to the Equator, divide the whole earth into five parts, called by the Greekes, Zones. Which appellation hath also been received, and is still in use among all our Latine Writers: notwithstanding they sometimes also use the Latine word, *Plaga*, in the same signification. But the Greekes do sometimes apply the word *Zona*, to the Orbes of the Planets, (In a different sence then is ever used by our Authors) as may appeare by that passage of *Theon Alexandrinus*, in his Commentaries upon *Araus*, ἔχει γὰρ ὁ ὕπερδος ὅτι ζώνας, ἢ ζώνους, τὰ ζῳδιακά, ὡν τὴν μὲν πρῶτην ἔχει ὁ κρόνος, τὴν δὲ δεύτεραν ὁ ζεύς. that is: There are also in the heavens seven Zones, which are not contiguous to the Zodiacque: the first whereof is assigned to *Saturn*, the second to *Jupiter*, &c.

Of these five Zones, three were accounted by

by the Ancient Philosophers and Geographers to be inhabitable and intemperate. One of them by reason of the Suns beames continually beating upon the same: and this they called the *Torrid Zone*, and is terminated by the Tropiques on each side. And the other two by reason of extreame cold, they thought could not be inhabited, as being so remote from the heat of the Suns beames: whereof one was comprehended within the Arctique circle, and the other within the Antarctique. But the other two were accounted temperate, and therefore habitable, the one of them lying betwixt the Arctique circle and the Tropique of *Cancer*; and the other betwixt the Antarctique and the Tropique of *Capricorn*.

Neither did this opinion, (although in a manner generally received among the Ancients) concerning the number and bounds of the Zones, even then want its opposition. For *Parmenides* would have that Zone, which they call the *Torrid*, to be extended farr beyond the Tropiques: so that he made it almost as large againe, as it ought to have been: but is withall reprehended for it by *Posidonius*, because he knew that about halfe of that space which is contained betwixt our Summer Tropique and the *Æquator*, was inhabited. So likewise *Aristotle* terminated the torrid Zone betwixt the Tropiques, and the temperate Zones, with the Tropiques, and the Arctique and Antarctique circle. But he also is taxed by the same *Posidonius*, in that he appointes the

Arctique

Arctique circles, which the Greekes will have to be mutable, to be the limits of the Zones. *Polybius* makes six Zones, by dividing the Torrid into two parts, and reckoning one of them from the Winter Tropique to the Æquinoctiall, and the other from thence to the Summer Tropique. Others following *Eratosthenes*, would have a certain narrow Zone, which should be temperate and fit for habitation, under the Æquinoctiall line: of which opinion was *Avicen* the Arabian. And some of our Modern Writers, (*Nicolaus Lyranus*, *Thomas Aquinas*, and *Campanus*) I know not upon what grounds, will have the terrestriall Paradise, spoken of in the beginning of *Genesis*, to be placed under the Æquinoctiall line. And so likewise *Eratosthenes* and *Polybius*, would have all that which they call the Torrid Zone, to be temperate. In like manner *Posidonius* contradicted the received opinion of the Ancient Phylosophers, because he knew that both *Syene*, which they place under the Tropique of *Cancer*, and also *Æthiopia*, which lieth more inward, and over whose heads the Sun lieth longer, then it doth upon theirs under the Æquator, are notwithstanding inhabited. Whence he concluded, that the parts under the Æquinoctiall were not inhabitable, because he saw that those under the Tropique wanted not inhabitants. Yet *Ptolomy* in his 2^d book and sixt Chapter of his *Almageste*, conceiveth those things, which are prepared of the temperateness under the line, to be rather conjecture

lecture then truth of story : and yet in the last Chapter of his fifth book of his *Geography*, he describes us a Country in *Æthiopia*, which he calleth *Agisymba*, and placeth far beyond the *Æquinoctiall* : (notwithstanding some of our Modern Geographers stick not to place it Northward from the *Æquator*, contrary to *Ptolomies* mind.) This inconstancy of *Ptolomy* hath given occasion to some to suspect, that the *Almagest*, and *Cosmography* were not the same Authours workes.

Now as concerning these conceits of the Ancients, about the number of the intemperate Zones, if they were not sufficiently proved to bee vain and idle, by the authority of *Eratosthenes* and *Polybius* : yet certainly it is very evidently demonstrated by the Navigations both of the *Portugalls*, and also of our own Countrymen, that not only that tract of land which the Ancients call the *Torrid Zone*, is fully inhabited ; but also that within the *Arctique* circle, above 70 degrees from the *Æquator*, all places are full of inhabitants. So that now, no man needs to doubt any further of the truth of this ; unlesse he had rather erre with Sacred and Venerable Antiquity, then be better informed by the experience of Moderne Ages, though never so strongly backed with undeniable proofes and testimonies.

PONT. Whereas our Author accuseth *Ptolomy* of inconstancy, in that in his *Almagest*. cap. 6. lib. 2. hee accounteth it a fable, rather then any

true, history whatsoever is reported of the inhabitants under the Equator: where as in his Geography lib. 5. cap. ult. he seemeth to contradict the same: I think that Pliny also is not free from the like fault. For whereas in his lib. 6. cap. 22. having discoursed of the Magnitude of the Isle Taprobane, (which is now thought to be Sumatra, and lyeth directly under the line,) out of Eratosthenes and Megasthenes: he presently adds, that besides the testimony of the Ancients, the Romans had better knowledge of the same, in the time of the Emperour Claudius, there being Embassadors sent from thence to Rome; who among other things, should relate, that with them Gold, & Silver was in high account, and that they had greater wealth then the Romans themselves; but yet that the Romans had greater use of riches, then they. Which words of Pliny, with many other there at large set down by him, if they be but compared with what himself elsewhere writeth, in his 2d book chap. 68. he will be found manifestly to contradict himself. For disputing in this place, and inquireing, how great a part of the earth is inhabited: Tres (saith he) terræ partes abstulisse nobis cœlum, &c. Three parts of the world the Heavens have robbed us of; to wit, the Torrid, or middle Zone, that is, whatsoever lieth betwixt the two Tropiques: and the two outmost or Frigid Zones: that is to say, whatever ground lieth betwixt either Pole, and the Arctique and Antarctique circles. According to that which the Poët sung of old:

Quarum quæ media est, non est habitabilis
æstu.

Nix tegit alia duos.

In English thus.

The midst of these is not inhabited,
Through heat : and two, with snow are covered.

For this is that which Pliny meaneth : that those two outwardmost are not habitable, by reason of extremity of cold, nor the other, through too violent heat. But that which is more to be wondered at in so great an Author, (who notwithstanding indifferently took up as well the common popular fables, as the extravagant fictions of the Poets also) is that which he very confidently relates out of Corlius Nepos, how that one Eudoxus, taking Ship in the Arabian gulf, came as farr as the Gades, two Isles upon the confines of Spain. Which voyage if we should but thoroughly examine, wil be found to be as much, as that all the Portugals, and our Countrymen at this day performe in their Sea voyage to the East Indies, when at touching upon the Cape of good hope, they twice crosse the line, and passe through the whole Torrid Zone. Not to speak any thing of that which he writes in his first book, twenty third Chapter, Namely, that there is never a yeare, that India doth not suck out of the Romane Empire, at the least 500000. Sesterces, by sending in such commodities, as they sell to the Romanes for an hundred times as much as they are worth in India. And that there is yearly Traffique by Shippe through the Red Sea, betwixt them and the Romanes, who are faine, for their safer passage, to defend,

defend themselves from Pirats, by going provided with bands of Archers. And here, all that can be said in Plinies defence, is, that those things which he relates in this second book, were written by him long before the rest which followeth: and that at that time, these Indian voyages were not so frequently undertaken, or the passages so well known unto the Romans: especially, for that in the bookes following, as namely the sixth book 17. and 23. Chapters. he saith, that the whole course of the voyage from Egypt into India, began but then first to be discovered, when as he was writing the same: and that Seneca having not long before begun a description of India, reckoned up therein 60. great rivers, and 122. Nations, to be contained within the same.

The principall cause of the habitablenesse and fertility of the parts under the Torrid Zone, is, in that the Sun shineth upon them but 12. houres: so that the nights beeing alwayes as long as the daies, the coldnesse of the one doth very much attemperate the excessive heat of the other. In like manner, that both the Frigid Zones are habitable, is to be attributed to the Sun, which in his course, through the six Northern signes of the Zodiacke, never sets in six months space to those that live under 84 degrees of latitude: so that by his continuall presence the extreame rigidity of the Climate is mitigated, and the cold, by this meanes, dispelled.

CHAP. V.

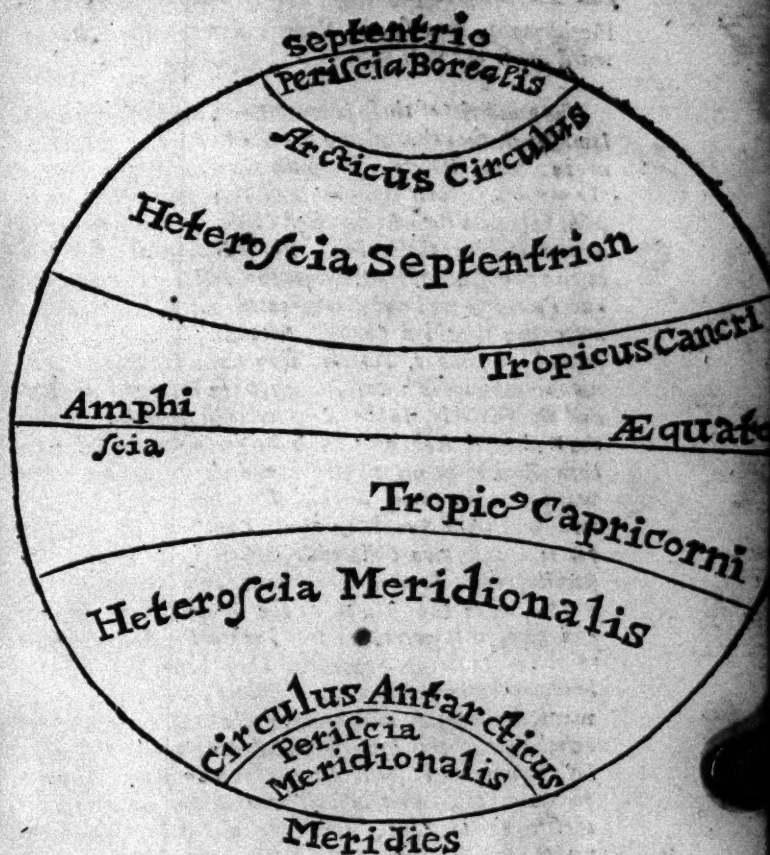
Of the Amphiscij, Heteroscij, and Periscij.



He Inhabitants of these Zones, in respect of the diversity of their noon-shadows, are divided into three kinds, *Amphiscij*, *Heteroscij*, and *Periscij*. Those that inhabit betwixt the two Tropiques are called *Amphiscij*, because that their noon-shadows are diversly cast, sometime toward the South, as when the Sun is more Northward then their Verticall point: and sometimes toward the North, as when the Sun declines Southward from their Zenith.

Those that live betwixt the Tropiques and A. & que circles, are called *Heteroscij*, because the shadows at noon are cast onely one way, and that either North or South. For the Sun never comes farther North, then our Summer Tropick; nor more Southward, then the Winter Tropick. So that those that inhabit Northward of the Summer Tropique, have their shadows cast alwayes toward the North: as in like manner those that dwell more Southward then the Winter Tropick, have their Noon-shadows cast alwaies toward the South. Those that inhabit betwixt the Arctique or Antarctique circles, and the Poles, are called *Periscij*: because that the *Gnomons* do cast their shadows circularly: and the reason hereof is, for that the Sun is carried round about, above their Horizon in his whole diurnall Revolution.

A figure of all theſe may here be ſeen:



PONT. The Heteroſciall Zone is therefore two-fold either Northern or Southern. The Northern is comprehended betwixt the Tropique of Cancer and the Arctic circle: and is called *ἑπὸς τοὺς ἑπτα* Septentrionalis, becauſe that in it the Sun-beames, at noon, are alwayes caſt to that part only that lyeth toward the ſole Arcticks

The Southern Heterosociall Zone, containeth all that space of ground that lieth betwixt the Tropique of Capricorn, and the Antarctique circle, And it is call'd *Tropica Meridionalis*, because the Noon shadowes are projected toward the South Pole only.

The properties of these severall Zones are these that follow. First, they that inhabit the midst of the Torrid Zone, are in a Right Sphere: for with them, both the Poles of the world lie in their Horizon: and their Zenith or Verticall point falleth in the Equinoctiall Circle. So that their peculiar Accidents are these. First, All the Starrs do rise and set in an equall space of time, except the Arctique and Antarctique Poles: as we have demonstrated out of Lelius, in our notes upon the third Chapter. Secondly, They have a perpetuall Equinoxe. Thirdly, They have the Sun vericall unto them twice in a yeare, namely, when hee entered into V and ~~the~~ Fourthly, In the Suns periodicall motion through the Zodiaque, look how much he goeth Southward from their Zenith, in his returne hee declines as far northward from the same. Fifthly, They have foure Solstices; two when the Sun is in their Zenith and Equinoctiall points: and two Collaterall, when he is in the Solsticiall points. Sixthly, They have two summers every yeare, when the Sun is in the Equinoctiall points: and two, as it were, winters, when the Sun declineth to either Tropique. Seventhly, They have five different kinds of shadows: to wit, Eastward, Westward, Northward, Southward, and Perpendicula. And therefore the Inhabitants of this Zone are called *Amphiscij*, that is to say, having their shadowes cast on both sides: The properties of those that inhabit toward the utmost border of the Torrid Zone, and being of the Northern Temperate, which have an Oblique Sphere, (for the Arctique Pole with them is elevated twenty three degrees and an halfe, and their Zenith fall th on the Tropique of Cancer,) are these following. First, All those Starrs that are comprehended wth in the compasse of the Arctique Circle, are alwayes above the Horizon: and contrariwise, those within the Circuite of the Arctique alwayes

lye hid. But if the intermediate Starrs, those that are Northward from the Equator, or a longer time above the Horizon, then they are under it: in like manner, as the other that decline more Southward, their Nocturnall Arch is greater then the Diurnall: onely those in the line itself, do rise and set in an equall space of time. Secondly, Their Artificiall dayes and nights are unequall. Thirdly, The Sun is in their Zenith but once in the yeare, and that is in the beginning of Cancer: so that it never ascends more Northward, but at all other times is Southward to them. Fourthly, They have two Solstices: one, when the Sun is in the begining of Cancer, which is their Verticall point: and the other when the Sun entereth into the begining of Capricorne, at which time the Sun hath the least elevation. Fifthly, They have also but one Summer and one Winter. They have foure differences of shadows, namely, Eastern, Western, Northern, and Perpendicular. And here is the beginning of the Heteroscij.

They that dwell on the Oblique Sphere, so that the Arctique Pole is elevated with them above 23. degrees, an an halfe, but lesse then 66. degrees, and an half: their Zenith or Verticall point alwayes falleth betwixt the Tropique of Cancer, and the Arctique Circle: whence they have these properties. First, Very many Stars with them are never observed to set: for the higher the Pole is elevated, the more Stars there are which alwaies appear; and so, in like manner, there are as many in the opposite Hemisphere that never rise. Secondly, Their Artificiall dayes and nights are equall. Thirdly, The

Sun is never in their Verticall point: but is alwayes at Noon Southward from them. Fourthly, They have one Summer, and one Winter, and two Solstices. Fifthly, They have also three different kinds of shadows, as namely, Eastward, Westward, and Northward. Whence they are called Heteroscij.

Those that inhabit about the end of the Northern temperate Zone, have the Pole Arctique elevated with them 66. degrees and an halfe: so that their Zenith falleth on the Arctique circle: whence they have these properties of Sphere. 1. All the Stars that lye within the Tropique of Cancer, and the Pole Arctique are of perpetuall Apparition: and contrarywise, those that are comprehended within the Opposite circle, are never seen to rise. 2. When the Sun is in the begining of Cancer, the Artificial day is with them twenty foure hours in length: and so likewise when the Sun entreth into Capricorne; the nights are as long. 3. The Sun, at noon, is alwayes Southward to them: but when he is in the begining of Cancer, and is near the very Horizon, he then seemes, in a manner, to be Northward. 4. They have two Solstices, and one Summer, and one Winter. 5. They have foure differences of shadows: as nameiy, Eastern, Western, Southern and Northern also, especially when the Sun entereth into the begining of Cancer. About these parts the Heteroscij end, and the Periscij begin.

Those that inhabit about the middle of the Northern Frigid Zone, have a Parallel or standing Sphere: for the Equinoctiall is their Horizon, whence they have consequently these properties.

1. No Starrs either rise or set at all: but whatsoever are circumscribed within the Equinoctiall circle and the very Pole, are carried about in circles Parallel both to the Equinoctiall and Horizon. 2. For the space of 6. months they have one continued day, the Sun in this space finishing his course through the Northern signes of the Zodiaque, and so likewise while he is in the opposite meridionall signes, they have a night of the same length. 3. They have but one Solstice, and that is, when the Sun entereth into the begining of Cancer. 4. They have one Winter and one Summer, or rather instead of a Summer they have some certain small remission of the extremity of cold. 5. Their shadows are carried round about them in a circle toward every part of the world: whence they are called Periscij, that is to say, having their shadows carried round about in a circular forme.

These are the properties of the Northerne Zones; which if they be referred to the opposite meridionall parts also, you have their properties likewise. For whatsoever is said of one Hemisphere, the same is also to be understood of the other opposite Hemisphere, only in a contrary sense. For when these that dwell in the Septentrionall Hemisphere, have their longest day, the opposite inhabitants in the meridionall part of the world have their shortest: and when they have their Summer, with those it is then winter, &c. And the same is also to be understood of the other Accidents also, concerning their shadows, the rising and setting of the Starrs, and the like.

CHAR. VI.

Of the *Periæci*, *Antæci*, and *Antipodes*.

He Inhabitants of the temperate Zones have by the Ancient Geographers been divided, in respect either of the same Meridian, or Parallel, or else equal situation in respect of divers parts of the Æquator, in such sort, as that to every habitation in these severall parts, they have added three other different in position, whose inhabitants they called, *Periæci*, *Antæci*, and *Antipodes*.

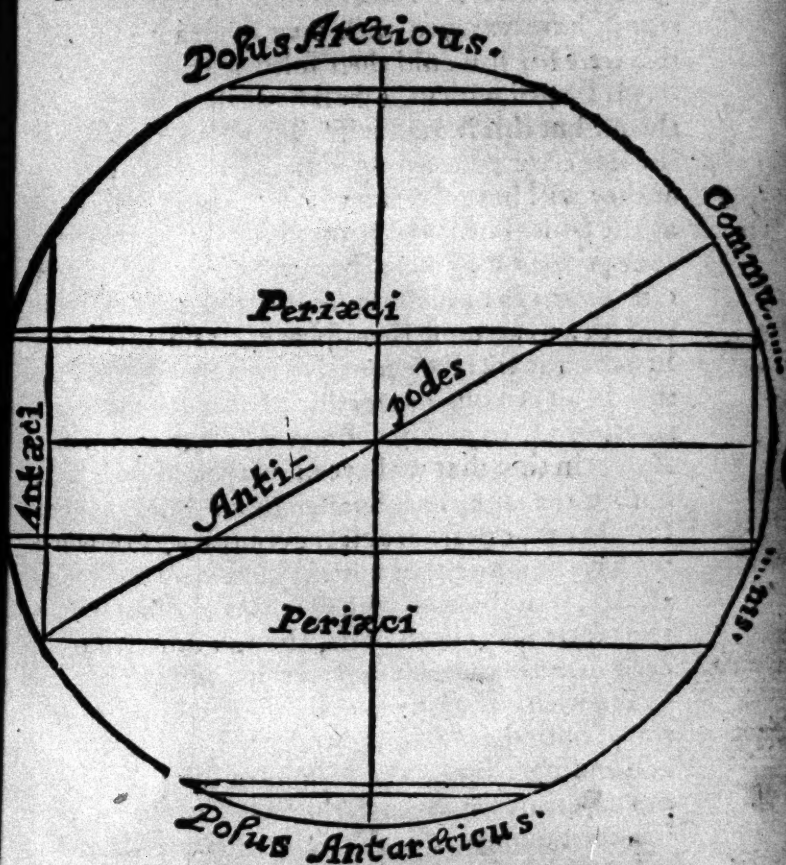
Periæci, are those that live under the same Meridian, and the same Parallel also, being equal distant from the Æquator; but in two opposite points of the same Parallel.

Antæci, are such as have the same Meridian, but live in diverse Parallels, yet equally distant from the Æquator, though in diverse parts.

Antipodes, (which are called *Antichtones*) are such as inhabite under one Meridian, but under two diverse Parallels, which are equally distant from the Æquator, and in opposite points of the same: or else wee may define them to be such, as inhabit two places of the earth, which are Diametrically opposite.

They therefore which are *Periæci* in respect of us, are *Antæci* to our *Antipodes*: & those that are *Antæci* to us, are *Periæci* to our *Antipodes*:
and

and Cælestiall Terestriall Globe.
and our *Periæci*, are *Antipodes* to those which
are *Antæci* to us.



We have also many accidents common with our *Periæci*. For we both inhabit the same temperate Zone; and have Summer, Winter, increase and decrease of daies and nights, at the same time. Only this difference is betwixt us, that when it is noon with us, it is midnight with them. Those Authors
that

that have added this difference also, that when the Sun riseth with us; it setteth with those that are our *Periæci*, have betrayed their own ignorance. For if this were so, it would then follow, that when the day is longest with us, it shall be at the shortest with them: but this is most false. They have committed the like error concerning our *Antæci* also; when as they will have the Sun to rise with us, and them at the same time. The ground of which their error perhaps may be, in that they conceived us and our *Antæci* to have the same Horizon, but that ours was the uppermost Hemisphere, and theirs the lower: the like they conceived of our *Periæci*. But this is an error unworthy of those that are but meanely versed in Astronomy. We agree with our *Antæci* in this, that we have midday, and midnight both at the same time. But herein we differ, that the seasons of the year are cleane contrary. For when we have Summer, they have Winter: and our longest day, is the shortest with them. We also inhabite temperate *Zones* both of us, though different from each other in the time and seasons.

But with our *Antipodes* all things are quite contrary, both daies and nights, with their beginnings and endings, as also the seasons of the year. For at what time we, through the benefit of the Sun, enjoy our Summer and the longest day: then is it winter with them, and the dayes at the shortest. So likewise when the Sun riseth with us, it setteth with them; and so contrary wise when it setteth with us, it riseth with them. For we inhabite the upper Hemisphere, and they the lower, divided by the same Horizon.

C H A P. VII.

Of Climates and Parallels.

According to the different quantity of the longest dayes, Geographers have divided the whole earth, on each side of the Æquator to the Poles in Climates and Parallels. A Climate they define to be a space of earth comprehended betwixt any two places, whose longest dayes differ in quantity halfe an houre. And a Parallel is a space, wherein the dayes increase in length a quarter of an houre: so that every Climate containeth two Parallels. Those Climates, as also the Parallels themselves are not all of equall quantity. For the first Climate, (as also the Parallel) beginning at the Æquator, is larger then the second, and the second is likewise greater then the third. Only herein, they all agree, that they differ equally in the quantity of the longest day.

The Ancients reckoned but 7 Climates at the first; to which number were afterward added two more, so that in the first of these numbers were comprehended 14 Parallels, but in the later, 18. Ptolomy accounting the Parallels by the difference of a quarter of an hour, reckoneth in all 24. by whole hours difference 4. by whole months, 6. So that blides the Æquator, reckoning the whole number of Parallels on each side, they amount to 58.

In the Meridian of a Materiall Globe, there
are

are described nine Climates, differing from each other by the quantity of halfe an hour. After these, there are, other also set according to the difference of an whole hour: and last of all those that differ in whole months are continued to the very Pole, each of them expressed in their severall latitudes. The distance of all, both Climates and Parrallels, together with their latitudes from the Æquator, and differences of the quantity of the longest dayes, are here fully exprest in this Table following.

Climates.	Parrallels.	The longest Summers day		Latitude and Elevation of Pole		The breadth of the Climates.	
		Hour.	Scr.	Hour.	Scr.	Deg.	Scrups.
0	0	12	0	0	0	0	18
	1	12	15	1	18	1	
1	1	12	30	8	34	8	25
	2	12	45	17	43		
2	4	13	0	16	43		
	5	13	15	20	33	7	50
3	6	13	30	23	10		
	7	13	45	27	36	7	3

4	8	14	0	30	47	6	9
	9	14	15	23	45		
5	10	14	30	30	30	5	17
	11	14	45	39	2		
6	12	15	0	41	22		
	13	15	15	43	32	4	30
7	14	15	30	45	29		
	15	15	45	47	20	3	48

Celestiall and Terrestiall Globe.

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Heteroclii.

Climates	Parallels.	The longest summers day		Latitude and Elevation of the Pole.		The breadth of the Climates.	
		Hour.	Ser.	Degr.	Ser.	Degr.	Ser.
8	16	16	0	49	1	3	13
	17	16	15	50	33		
	18	16	20	51	58	2	44
9	19	16	45	53	17		
	20	17	0	54	29	2	17
10	21	17	15	55	34		
	22	17	30	56	37	2	0
11	23	17	45	57	34		
	24	18	0	58	26	1	40
12	25	18	15	59	14		
	26	18	30	59	55	1	26
13	27	18	45	60	40		
	28	19	0	61	18	1	13
14	29	19	15	61	33		
	30	19	30	62	25	1	1
15	31	19	45	62	54		
	32	20	0	63	22	0	52
16	33	20	15	63	4		
	34	20	30	64	0	0	46
17	35	20	45	64	30		
	36	21	0	65	49	0	36
18	37	21	15	65	6		
	38	21	30	65	21	0	29
19	39	21	45	65	35		
	40	22	0	65	47	0	22
20	41	22	15	65	57		
	42	22	30	66	4	0	17
21	43	22	45	66	14		
	44	23	0	66	0	0	11
22	45	23	15	66	25		
	46	23	30	66	0	0	5
23	47	23	45	66	0		
24	48	24	0	66	31	0	0

Months.

Periscli.

Here the Climates begin to be account- ed by months, from 66 gr. 31. m. where the day is 24 hours long to the Pole it self, where it is 6. months in length.	1	67	15
	2	69	30
	3	73	20
	4	78	30
	5	84	0
	6	90	0

MEMORANDUM FOR THE RECORD

DATE	PLACE	REMARKS	PAGE
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The second Part,

CHAP. I.

*Of such things as are proper to the Cælestiall
Globe : and first of the Planets.*

Hitherto, hath our discourse been concerning those things which are common to both *Globes* : We will now descend to speak of those that properly belongs to each of them in particular. And first of those things that only concern the *Cælestiall Globe* : as namely the *Starrs*, with their severall configurations.

The whole number of *Starrs* hath been divided, by the Ancient Astronomers, who first applied themselves to the diligent observing of the same, into two kinds. The first is of the *Planets*, or wandering *Starrs* : the other of the fixed. The first of which, they therefore called *Planets* or *Wanderers*. because they observe no constant distance or situation; neither in respect of each other, nor in respect of those that are called fixed *Starrs*. And these were so called, because that they were obser-

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ved

ved alwayes to keep the same situation and distance from one another, as is at large proved Ptolomy, in his *Almagest*, lib. 7. cap. 1. out of his owne observations, diligently compaired with those delivered by Hipparchus.

PONT. The Starrs are divided into Planets, or wandering Starrs, and fixed: not as if these were indeed fixed in one certain place, and altogether without motion, and the other only moveable and erraticall: but these appellations are onely given then comparatrully; in which sence also they are to be understood. For seeing that the fixed Starrs were observed alwayes to keep the same places in the eighth Sphere, and the same distance from each other: notwithstanding that they are alwayes in continuall motion, caused by the vertue of the first Moveable, which carrieth them about in the space of twenty foure hours. But the Planets, besides this motion, have a proper motion of their owne, so that they keep neither their the same distance from the fixed Starrs, nor yet the same aspect to each other: for these reasons were the one called Fixed, and the other Planets. For otherwise if the Planets be considered severally, each one by himselfe, there is nothing more certain then their periodicall motion. So that Tully, alluding hereto, would have the Planets to bee called *Errantes*, by Antiphrasis, quam minimè errantes.

The Planets, (exceeding those two greater lights, the Sun and Moon) are five in number

number. All which, beside the Diurnal motion, by which they are carried about from East to West, by the Rapture of the first Moveable, have also a free proper motion of their owne, which finish from West to East, according to the succession of the Signes, upon the Poles of the Zodiaque; each of them in a severall manner and space of time: Their order in the Heavens, and periods of their motions being such as followeth.

Saturne, called in Greek *Kβρ* or *Φαίδων*, (and by *Julius Higinus*, *Stella Solis*, the Star of the Sun) is the highest of all the Planets: and goeth about the great firmament: but doth not therefore appear to be the least of all the Planets, as *Pliny* hence conjectured. Hee finisheth his Periodical course in twenty nine yeares, five months fifteen dayes, according to *Alfraganus*.

Jupiter, in Greek *Ζυς* and *Φαίνορ*, moveth through the Zodiaque in the space of eleven yeares, ten moneths, and almost 16. dayes.

Mars, *Αρης* and *Προπερ*, (which is also called by some, *Heracles* his Star.) finisheth his course in two yeares.

Sol, the Sun in Greek *Ηλ*, performeth his course in a yeare, that is to say, three hundred sixty five dayes, and almost sixe hours.

Venus, *Αφροδιτη*, (called by some *June's* Starr, by others, *Isis*, and by others, *The Mother of the Gods*:) when it goeth be-

fore the Sun, it is called ☿, the day Star appearing like another lesser Sun, and as it were, maturating the day. But when it followeth the Sun, in the Evening, protracting the light, after the Sun is set, and supplying the place of the Moone; it is then called ♀, the Evening Star. The names of which Star, *Pythagoras Samius* is said first to have observed about the thirte 2^d. Olympiad, as *Pliny* relates, lib. 2. cap. 8. It performeth its course in a years space, or thereabout: and is never distant from the Sun above forty six degrees, according to *Timæus* his computation. Notwithstanding, our later Astronomers, herein much more liberal then he, allow it two whole signes, or 60. degrees, which is the utmost limit of its deviation from the Sun.

Mercury, in Greek *ερμης*, and *Ζηλας*, (called by some *Appollo's* Star) finisheth his course through the Zodiacke in a year also: And according to the opinion of *Timæus* and *Sofigenes*, is never distant from the Sun above 25. gr. or, as our later writers will have it, not above a whole sign, or 30. degrees.

Luna, Σελήνη the Moon, is the lowest of all the Planets, and finisheth her course in twenty seven dayes, and almost eight hours. The various shapes and appearances of which Planets, (seeming sometimes to be horned, sometimes equally divided into two haltes, sometimes finished like a lamp-
perfect

perfect circle, and sometimes in a respect circular forme,) together with the other diversities of this Star, were first of all observed by *Endymion*; as it is related by *Pliny*: whence sprung that Poëricall fiction, of his being in love with the Moon.

All the Planets are carried in Orbes, which are *Eccentricall* to the earth: that is, which have not the same center with the earth. The Semidiameter of which Orbes, compared to the Semidiameter of the earth, have this proportion, as is here set down in this Table.

Of what parts the semidiameter of the earth is 1. Of the same the semidiameter of the Orbes of	[Luna	} 1 {	{ 48. 56 m.	
	Mercury		{ 116. 3 m.	
	Venus		{ 641. 45. m.	
	Sol		{ 1165. 23 m.	
	Mars		{ 50. 2. 4 m.	
	Jupiter		{ 11611. 31 m.	
	[Saturne]		{ 17225. 16. m.	

The Eccentricities of the Orbes, compared to the Orbs themselves, have this proportion,

Of what parts the Semidiameter of the Different is 60. Of the same the Eccentricity of.	[Luna	} 18 {	{ 12. 28. m. 30 sec.	
	Mercury		{ 2. 0. m.	
	Venus		{ 1. 8. m.	
	Sol		{ 2. 16. m. 6. sec.	
	Mars		{ 6. 0 m.	
	Jupiter		{ 2. 55 m.	
	[Saturne]		{ 3. 25 m.	

Microlycus, out of Alphons.

The Eccentricities of some of the Planets, (especially of the Sun) are found to have

decreased and growne less since *Ptolomyes* time. For *Ptolomy* sets down the Eccentricity of the Moon to be 12. gr. 3. m. but by *Alphonſus* it was found to be but 13 gr. 28. m. and an halfe. *Ptolomy* assigned Eccentricity to *Venus* 1 gr. 14. m. *Alphonſus* 1. gr 8. m. *Ptolomy* found, by his owne obseruation, and also by those that *Hipparchus* had made, that the Eccentricity of the Sun was 2 gr. 30. m. *Alphonſus* obserued it in his time to be but 2 gr. 16. m. and the 10th. part of a minute. In the year of our Lord 1312 it was found to be 2 gr. 2. m. 18. sec. *Copernicus* found it to be lesse yet then that, and to be but 1 gr. 56. m. 11. sec. So, that with ut just cause, did the Illustrious *Julius Scaliger* think *Copernicus* his writings, for this reason, to deserve the Sponge, and the Author himselfe the Bastinado: he eln dealing more hardly with *Copernicus*, then he deserves.

PONT. Besides the Eccentricities of the Planets, it is worth our paines also to observe their Magnitudes: And this consists especially in the knowledge of their Diameters, and what proportion they beare to each other. For the Diameter of a Planet, compared to the Diameters, of the Earth, is after this manner following.

The Diameter of	Saturne	Compared to the Di- ameter of the Earth is as	19	10	3
	Jupiter		32		7
	Mars		7		6
	Sol		11		2
	Venus		3		10
	Mercury		1		28
	Luna		5		17

The

The Diameter of the Sun compared to the Diameter of the Moon, beareth the same proportion, that is betwixt 187. and 10.

And now that which is said may be demonstrated by an example : let us suppose the Diameter of the Sun, in proportion, to the Diameter of the Earth, to be (as is already shewed) as 11. to 2. The Cube therefore of the Sun is 11. and the Cube of the Earth. 2. Now these Diameters being multiplied cubically and the greater Cube divided by the lesse, the difference of their severall Globes will appear. For if you multiply 11. by 11. there ariseth 121. which number being multiplied again by 11. the whole will be 1331. So likewise multiply 2. cubically, that is to say, by it selfe, and there riseth 4. which being again multiplied by 2. ariseth 8. Now divide the greater Cube, 1331. by 8. and the product will be 166½ which is the difference of the Globes of the Sun, and the Earth.

And thus much may suffice us to have spoken of the Planets : and if any desire a more copious Narration of the same, they may have recourse to Ptolomy, Copernicus, and others, that have written the Theories of the Planets. For a more large description of these things seems not to stand with our purpose : especially for that by reason of their Erraticall motion, they cannot be expressed in a Globe. Let thus much therefore be spoken of them, as by the way only.

CHAP. II.

Of the fixed Starrs, and their Constellations.

ANd here, in the next place, we intend to speak of the Fixed Starrs, and their *Asterismes*, or *Constellations*, which *Pliny* calls *Signa* and *Sidera*, *signes*. Concerning the number of which Constellations, as also of their figure, names, and number of the Starrs they consist of, there is diversity of opinion among Authors. For *Pliny* in his 2^d book, 41. chap. reckoneth the whole number of the *signes* to be 72. But *Ptolomy Alfraganus*, and those which follow them, acknowledge but 48. for the most part: notwithstanding some have added to this number one, or two more; as *Berenices Haire*, and *Antinous*. *Germanicus Cæsar*, and *Festus Avienus Rufus*, following *Aratus*, make the number lesse. *Julius Higinus* will have them to be but 42. reckoning the *Serpent*: and *The man that holdeth it*, for one *signe*: and he omitteth the little *Horse*: and doth not number *Libra* among the *signes*: but he divideth *Scorpio* into two *signes*, as many others also doe. Neither doth he reckon the *Crow*, the *Wolf*, nor the *South Crown* among his Constellations, but onely names them by the way. The *Bull* also, which was described to appear but half, by *Hipparchus*, and *Ptolomy*, and those that follow them: the same is made to be wholly apparant, both by *Vitruvius*, and *Pliny*, and also before them, by *Nicander*, if we may believe *Theon*, *Aratus* his Scholiast: who also place the *Pleiades* in his back. Con-

Concerning the number also of the Starrs; that goe to the making up of each Constellation, Authors do uery much differ from *Ptolomy*, as namely, *Julius Higinus*, the Commentator upon *Germanicus*, (whether it bee *Bassus* as *Philander* calles him : or whether those Commentaries were written by *Germanicus* himself, as some desire to prove out of *Lactantius*) and sometimes also *Theon*, in his Commentaries upon *Aratus*; and *Alfraganus* very often.

Now if you desire to know what other reason there is, why these Constellations have been called by these names. save onely, that the position of the Starrs doth in some sort seeme to expresse the formes of the things signified by the same : you may read *Bassus*, and *Julius Higinus*, abundantly discoursing of this argument out of the fables of the *Greekes*. *Pliny* assures us, (if at least we may believe him) that *Hipparchus* was the man that first delivered to posterity the Names, Magnitude, and Places of the Stars. But they were called by the same names, before *Hipparchus* his time, by *Timochares*, *Aratus*, and *Endoxus*. Neither is *Hipparchus* ancienter then *Aratus*, as *Theon* would have him to be. For the one flourished about the 420. yeare from the beginning of the Olympiads : as appeareth plainly out of his life written by a Greek Author. But *Hipparchus* lived above 600. yeares after the beginning of the Olympiads : as his observations, delivered unto us by *Ptolomy*, doe sufficiently

ently testifie. Besides that, there are extant certain Commentaries upon the *Phænomena* of *Eudoxus* and *Aratus*, which goe under *Hipparchus* his name: unlesse perhaps they were written by *Eratosthenes* (as some rather think) who yet was before *Hipparchus*.

PONT. That which is written of *Hipparchus*, is not to be understood any further, then touching the distinction of the Stars of the first, second, and third magnitude. For so *Servius* in his Commentaries upon the 1. lib. *Geogr. Hipparchus* (inquit) scripsit de signis, &c. *Hipparchus* (saith he) wrote of the Signes, and reckoned up, how many bright Stars, how many of the second degree of light, and how many of scure Stars there were in each constellation. For otherwise, that the Stars were known by the same names 1000. yeares before *Hipparchus*, may be proved out of *Seneca*, who in his 7. lib. *Natural. Quest.* chap: 25. saith thus *Nondum tunc anni*, &c. It is not (saith hee) 1500. yeares yet, since Greece first began to number the Stars, and to give them certain Appellations, Now *Seneca*, we know, was put to death by the command of *Nero*, in the 65. yeare after Christ, And *Hipparchus* lived not above 283. yeares before Christ, in the time of *Ptolomies Philadelphus*. And *Job* also, whom *Philo Judæus* reporteth to have married *Dina*, *Jacob's* daughter, mentioneth these names, *Arcturus*, *Pleiades*, and *Orion*, if wee may trust *St. Hierom's* translation in this case, cap. 9. verse. 9. Who maketh (saith he) *Arcturus*, *Orion*, and *Pleiades*, and the

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the Starrs in the remotest parts of the South. So likewise the Prophet Amos, chap 5 vers 8. *Quærite (inquiet) opituncem Pleiadum & Orionis, &c. Seeke ye him that made the Pleiades and Orion, &c.*

Now it is probable, that there were two kinds of men, that reduced the Starrs into constellations: and these might probably be Husbandmen, and Mariners. The Husbandmen perhaps might make these, to wit; the Ram, the Bull, the Ear of Corne in the Virgins hand, the young Kids, the Goat, the Waggoner, the little Goat, the Waggon: all which, are names used also by Homer. Of the Mariners, the Pleiades, the Hyades, the Whale, and the like names seem to have been invented. according to that of Virgil, in the first of his *Georgicks*.

Navitatum Stellis numeros & nomina fecit:
Pleïdæ, Hyadæ, clarumq; Lycaonis Astitum.
Which is thus translated into English Verse by
T. May.

The Sailers number then, and nam'd the Star:
The Pleiads, Hyads, and the Northern Carre.

And now to whom do those other new Constellations above the Antarticke Pole, owe their now so well known names, but to the Portugals, Hollander, and English Sea-faring men? Neither are those men at all to be regarded, that condemn these usual names of the Starrs, and Constellations, as unfit to be used by Christian men. For seeing they are now used, without the least shew of superstition, and that there is very great necessity of these Appellations, in as much

as

as without them there could be no agreement or accord in these Arts and science (for these very names are used all the world over, where ever the same Arts are taught or professed) I see no reason but that we may lawfully use these names, til such time as, the true names, wherewith the great Creator of all things, at the first called ere y Star as David witnesseth in the 146 Psalm be made known unto us. As concerning the practise of the Arabians, who rejected these humane figures, having substituted in their places the forme of Beasts: you may read Joseph Scaliger, in his Commentaries upon Manilius.

Pliny in his 2. Book, 41. chapter affirmeth, (though I know not upon whose authority or credit) that there are reckoned 1600. fixed Starrs, which are of notable effect and vertue. Whereas *Protony* reckoneth but 1022. in all, accounting in those which they call *Sporades*, being scattered here and there, and reduced to no Asterisme. All which, according to their degrees of light, he hath divided into 6. orders. So that of the first Magnitude he reckoneth 15. of the second 45. of the third, 208. of the fourth. 474. of the fifth, 217. of the sixth, 49. to which we must add the 9. obscure ones, and 5. other. which the Latines call *Nebulose*, cloudy Starrs. All which Starrs, expressed in their severall Constellations, Magnitudes, and names, both Latine and Greek, and some also with the names by which they are called in Arabique) you may see prescribed in the Globe.

PONT.

PONT. Now as we have already shewed, how by comparing the Diameters of the Planets, with the Diameter of the Earth, their magnitude may be known: in like manner also, may the magnitude of the fixed Starrs be found out: as may be seene by this scheme.

The Diameter of a Starr of the	[1]	is to the Earths Diameter, as	[119	4]
	2		269	60]
	3		25	6]
	4		19	5]
	5		19	36]
	6		21	8]

More over concerning those other fixed Starrs about the Southern Pole, which were unknown to Ptolomy and the Ancients, and now of late yeares discovered by the Portugals and Hollanders; wee shall set down their names also in their due place.

All these Constellations (together with their names in Arabique, as we find them partly set down by Alfraganus, partly by Scaliger in his Commentaries upon Manilius, and Grotius, his Notes upon Aratus his Asterismes, but especially as Jacobus Christmannus hath delivered them unto us out of the Arabique Epitome of the Almagest) we will set down in their order. And if any desire a more copious declination of the same, wee must reter him to the 7. and 8. bookes of Ptolomies Almagest, and Copernicus his Revolutions, and the Prutenicke Tables digested by
Erasmus

Erasmus Reinbolt : where every one of these Starrs is reckoned up, with his due longitude, latitude, and magnitude annexed.

PONT. You may also see *Christophorus Clavius* in his Commentary upon *Johan. de Sacrobolco* cap. 1. And above all the rest *Tycho Brahe* who in his book of the New Starrs that appeared in the year 1572. hath proposed tables of the longitude and latitude of all the fixed Starrs that can conveniently be seen in these latitudes, according to his owne most accurate observations : as y^e may see in the asorenamed book, pag. 258. and so forward.

But here you are to observe by the way, *Copernicus* and *Erasmus Reinbolt* do reckon the longitude of all the Starrs, from the first Star in *Aries* : but *Ptolomy* from the very Intersection of the *Æquinoctiall* and *Ecliptick*. So that *Victorinus Strigelius* was in an error. when he said, that *Ptolomy* also did number the longitude of Starrs from the first Star, the head of *Aries*.

CHAP. III.

Of the Constellations of the Northern Hemisphere.

THE first is called in Latine *Ursa Minor*, and in Arabique *Dab Alasgar*, that is to say, the lesser Bear, and *Alrucaba*, which signifieth a Wagon or Chariot : yet this name is given

given also to the hindermost Starr in the taile, which, in our time, is called the Pole Starr, because it is the nearest to the Pole of any other. Those other two in the taile, are called by the Greekes χορευταί, that is to say, Saltatores, Dancers. The two bright Starrs in the fore part of the body, the Arabians call *Alferkathan*, as *Alfraganus* writeth: who also reckoneth up seven Starrs in this Constellation, and one unformed near unto it. This constellation is said to have been first invented by *Thales*, who called it the *Dog*, as *Theon* upon *Aratus* affirmeth.

The second is *Ursa Major*, the *Great Beare*: in Arabique, *Dub Alacber*. The first Starr in the back of it, which is the 16. in number, is called *Dub xxt* 𐤃𐤁𐤅𐤃𐤁, and that which is in the flanke, being the 17. in number, is called *Mizar*, or rather, as *Scaliger* would have it, *Mizar*, which signifieth (saith he) *locum praecinctionis*, the girthing place. The first in the taile, which is the 25. in number, is called by the *Alfonfines*, *Aliare*, and by *Scaliger*, *Aliath*. This Asterisme is said to have been first invented by *Nauplius*, as *Theon* affirmeth. It hath in all 27. Starrs: but as *Theon* reckoneth them, but 24. Both the Beares are called by the Greeks, according to *Aratus*, ἀρκταί, which signifieth a *Wagon* or *Chariot*. But this name doth properly appertain to those seven bright Starrs in the great Beare, which do something resemble the forme of a Wagon. These are called by the *Arabians*,
Benetip

Beneth As; i. e. *Filix Feretri*, as *Christmannus* testifieth. They are called by some, though corruptly, *Benenas*, and placed at the end of the taile. Some will rather read it *Benethasch*, which signifies *Filium Vrsæ*. The Grecians in their navigations were wont alwayes to observe the great Bear: whence *Homer* gives them the Epithete *ἰλιώτας* as *Theop* observes; for the Greekes call the great Bear *ἰλὺν*. But the *Phœnicians* alwayes observe the lesser Beare, as *Aratus* affirmeth.

The third is called the *Dragon*, in Arabique *Alanin*, and it is often called *Aben*: but *Scaliger* readeth it *Taben*; whence he calleth that Starr which is in the Dragons head, and is the 5. in number, *Rastaben*, though it be vulgarly written *Rasaben*. In this Constellation there are reckoned 31. Starrs.

The fourth is *Cepheus*, in Arabique *Aludaf*. To this Constellation, besides the two unformed Saris, which are hard by his *Tiara*, they reckon in all, 11. among which, that which is in number the 4. is called in Arabique *Alderaimin*, which signifieth, the right Arme. This Constellation is called by the *Phœnicians* *Phicares*, which is interpreted *Flammiger*, which appellation, peradventure they have borrowed from the Greeke Word *πυρραγος*.

The fifth is *Bootes* *Βούτης*, which signifieth in Greeke an Herdsman, or one that driveth Oxen.

Oxen. But the Arabians in flaking the word, as if it had been written *Bootes* or *Boon*, which signifies a *Clamator*, Cryer, call it also *Albava*, that is to say *Vociferator*, one that maketh a great noyse or clamor: and *Alramech*, *Alramech*, that is the Launce-bearer. Betwixt the legs of this Constellation, there stands an unformed Star of the first magnitude, which is called both in Greek and Latine *Arcturus*, and in Arabique *Alramech*, or the brightest Starr, *Somech haramach*. This Starr *Theon* placeth in the midst of *Bootes* his belt or girdle, The whole Constellation consisteth of 22. Starrs.

PONT. There is mention made of *Arcturus* also in *Job*, cap. 9. verse. 9. according both to *Hieroms* translation, and also the Greeke translation of the 70. as we have noted already. But in the Hebrew text it self, it is called *Gnalsch*, or *Asch*; from the root *Gnuich*, which signifieth *Congregabit*. *Hesychius* in his *Onomasticon* observeth that *Bootes* is also called sometimes *Orion*: according to that of *Manilius*.

Arctox & Orion adversis frontibus ibant.

In Which signification *H. Grotius* in his notes upon *Aratus* his *Asterismes*, thinks it is here to be taken. Sometimes also the whole Constellation of *Bootes*, or *Arctophylax*, is called *Arcturus*; from the Greek word *ἄρκτος*, a Bear, and *ἰπός*, which is the same that *φυλάξ*, a Keeper: as *Scaliger* upon *Manilius* observes. Now that the Hebrewes call *Arcturus* by a word signifying a congregating, or gathering together, the reason

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I take to be, because he hath the great Bear joyned to him. For this Star standeth behind the taile of the great Bear, whence it seemeth to have it's name, quasi *apulus* & the keeper of the Bear, whence Pliny also, lib. 2. cap. 41. *Bootes sequitur Septentriones.*

The sixth Constellation is *Corona Borea*, the North Crown, called by the *Arabians*, *Aclilafchemali*, and that bright Star, which is placed where it seemeth to be fastened together, and which is the first in number, is called in *Arabique* *Alphecca*, which signifieth *Solutio*, an untying or unloosing. It is also called *Monic*: but this name is common to all bright Stars. The whole Constellation consisteth of eight Stars.

The seventh is *Hercules*, in *Arabique*, *Alcheti hale rechabateb*, that is one falling upon knees, and sometimes absolutely *Alcheti*: for it resembleth one that is wearied with labour (as *Aratus* conceives) whence it is also called in *Latine* *Nisus*, or *Nixus*; (which in *Vitruvius* is corrupted into *Nesses*;) and the *Greekes* call it *ερυβραος* that is to say, One on his knees. The Star which is first in number in the head of this Constellation, is called in *Arabique* *Rafacheti*, not *Rafaben*, as the *Alfonfines* corruptly have it; and the 4. Star is called, *Marfic*, or rather *Marfic*, *Reclinatorium*, that part of the Arme on which we leane. The eight Starr, which is the last of the three, in his Arme, is called *Maxim*, or *Maasim*, which signifieth *Strength*. This Constellation

Celestiall and Terrestriall Globe,

tion hath eight Starre, besides that which is in the end of his right foot, which is betwix him and *Bootes*, and one unformed Starr at his right Arme.

The eight is the *Harpe*, called in Latine *Lyra*, in Arabique *Schalias*, and *Alvakah*. i. *Cadens* sc. *Vulture*, the *Falling Vulture*. It consisteth of 20. Stars, according to *Hipparchus* and *Ptolomy*: but *Tymochares* attributed to it but 8. as *Theon* affirmeth: and *Alfraganus* 11. The bright Star in this Constellation, being the first in number, *Alfonsus* calleth *Vega*.

The ninth is *Gallina*, or *Cygnus*, the Hen, or Swan, and is called in Arabique *Aldigaga* and *Altayr*, that is the flying Vulture. To this Asterisme they attribute, besides those two, unformed, near the left wing, 17. Stars, the 5. of which is called in Arabique *Deneb Adigege*, the tale of the Hen; and by a peculiar name, *Arieded*, which they interpret, *quasi redolens lilium*; smelling as it were of Lilies.

PONT. And here, in this place, it is worth our noting that there was a new Star observed in the breast of the Swan, in the yeare one 1600 which see many Mathematicians on work and among the rest, besides *Justus Byrgius* Engineer to the Emperor, *Johannes Beierus*, *Mætlinc*, and others: *Johan. Kepler* also, who had some time been *Tychoes* Scholler, put forth a Mathematicall Tract of it. when it had now continued in the same place of that constellation for the space of 6. yeares, being a Star about the third Magnitude.

The 10th is *Cassiopeia*, in *Arbiaque Dhab*
Aleurf, the Lady in the Chayre: and it consist-
 eth of 13. Stars: among which the 2^d in num-
 ber *Alfonfus* calleth *Scheder*, *Sealiger Seder*,
 which lignifieth a Bread.

PONT. There was another new Star also ap-
 pared in *Cassiopeia*, being as great as a Star of
 the first Magnitude, in the year 1572. Novem-
 11. th and it lasted 11. Months. Of which Star
 there were divers opinions amongst Astronomers:
 yet they all agreed in this, that it was placed in the
 seat of *Cassiopeia* in the very Skie, and in *Via-*
laetea. and those that had observed it more accur-
 ately & among the rest, the noble *Tycho Brahe*, who
 also wrote a large Volume of the same, full of most
 accurate observations did all of them unanimously
 confesse that they could not perceive that it had any
 Parallaxe at all, nor yet distinguish any differ-
 ence betwixt its True and Apparent place; and al-
 so added, that it alwayes kept the same situation in
 the Eighth Sphere, whence they manifestly are refu-
 ted, who deny that there hath ever any new Star
 risen in the heavens since the first Creation: among
 which is *Lambertus Danzus*, as may appeare in
 his *Phylic. Christian. Tract. 4. cap. 10.* But he
 ought to have mentioned, not this Star only, but al-
 so that other, which (as *Pliny* testifieth) was obser-
 ved by *Hipparchus* to have been generated in the
 very Skie it self in his time. For where as the same
Danzus thinkes, that the Star which appeared at
 our SAVIOURS Nativity, was either
 some Comet, or else some one of the Ordinary
 Stars,

Starrs, which at that time kept an extraordinary course in its motion: the first of these cannot be granted; because it is expressly called a Star: neither is the second of any force because, it is not probable, that the Magi, who were so skilfull in the knowledge of the Starrs, should be so much deceived as to mistake an old star, that had only changed its place, for a new one. Neither yet do we believe this to be the same that Hipparchus is said to have observed in his time, or this other, which, as we have said, was seen Anno 1572. but rather that it was a different star from both. For further satisfaction whereof, I refer my reader to Tycho de Nova Stella pag. 319. &c.

The 11. th is *Perseus*, *Chamil Ras Algol* that is to say, Bearing the head of *Medusa*; for that Star which is on the top of his left hand, is called in Arabique *Ras Algol*, and in Hebrew *Rosch hassutan*, the Devils head. This constellation hath besides those three unformed, 26. other Stars; of which, that which is the seventh in number, *Alfonfus* calleth *Alchcemb*, for *Alchenib*, or *Algeneb*, according to *Scaliger*, which signifieth a side.

The 12th is *Auriga*, the Waggoner, in Arabique *Roha*, and *Alemassich Alhanam*, that is, One holding the raines of a bridle in his hand. This Atermisus hath 14. Stars: of which that bright one in the left shoulder, which is also the third in number, is called in Greek, *αἰγ* *Capra*, a Goat; and in Arabique *Alhaiok*. or, as *Scaliger* saith, *Alatod*, which signifieth a Hee Goat: and the two which are in his left

head, and are the 8th and 9th are called *epion*, *Hædi Kids*; and in Arabique, *s Alsonsus* hath it, *Saclatani*, but according to *Scaliger*, *Sadateni*, the kinmost arme. This Configuration of these Stars was first observed by *Cleostratus Tenedius*, as *Higinius* reporteth.

The 13th *Aquila Albhakkab*, the Eagle: the modern Astronomers call it, the flying *Vulture*, in Arabique *Altayr*; but *Alfraganus* is of a contrary opinion, for he calleth the Swan by this name, as we have already said, they reckon in this Alterisme 9. Stars; besides 6. other unformed, which the Emperour *Hadrian* caused to be call *Antinous*, in memory of *Antinou*, his Minion.

The 14th is the *Dolphin*, in Arabique *Aldelphin*, and it hath in it 10. Stars.

The 15th is called in Latine *Sagitta*, or *Telum*, the Arrow or Dart, in Arabique *Alsham*: it is also called *Istusc*, which word *Grotius* thinkes is derived from the Greek word *istis* signifying an arrow. It containeth 5. Stars in all.

The 16th is *Serpentarius* the Serpent bearer; in Arabique *Alhava*, and *Hafalangue*. It consisteth of 24. Stars, and 5. other unformed. The first Star of these is called in Arabique *Rafalangue*.

P O N T. There was also discovered a new Starr in the foot of the Serpent-bearer, Anno. 1605. which might have been reckoned among the Stars of the third magnitude. It began first to appeare about October, in the yeare aforesaid, and

and about February, the yeare following, being 1606. it vanished out of sight. Kepler wrote a Book of this Star also, unto whom you may have recourse for further satisfaction.

The 17th is *Serpens*, the Serpent, in Arabique *Albosa*: it consists of 18. Stars.

The 18th is *Equiculus*, the little Horse, and in Arabique *Kataat Alfaras*, that is in Greek *ὑποταπὶ ἵππου*, as it were the fore part of a Horse cut off. It consisteth of 4. obscure Stars.

The 19th is *Pegasus*, the great Horse, in Arabique *Alfaras Alakham*; and it hath in it 10. Stars. The Star on the right shoulder, which is called *Almenkeb*, and is the third in number, is also called *Seat Alfaras*, *Brachium equi*. And that which is in the opening of his mouth, and is numbred the 17th is called in Arabique *Enif Alfaras*, the Nose of the Horse.


The 20th is *Andromeda*, in Arabique *Almara Almasalsela*, that is, the Chained Woman; *Alfraganus* interprets it *Feminam, quæ non est experia viri*, a Woman that hath not known a man. This Constellation containeth in it 23. Stars: whereof that which is the 12th in number, and is in the girdling place, is commonly called in Arabique *Mirach*, or, according to Scaliger, *Mizar*: and that which is the 5th is called *Almac*, or rather *Almaac*, which significeth a socke or bokin.

The 21st is the *Triangle* in Arabique *Almat'ah*, and *Muelathin*, which signifies *Triplix*. It consisteth of 4. Stars.

PONT. Among all these constellations in the Northerne Hemisphere, which are in all 21. there are but three Stars onely of the first Magnitude. The first of which is that in the left shoulder of Erichthonius, or the Waggoner, called in Latine Capella. The second is the bright Star in the Harpe: and the third is Arcturus, betwixt the legs of Bootes. Now the whole number of Stars in this part of the Heavens, reckoning in these also which are of the 2^d 3^d 4th 5th and 6th magnitude, with the obscure and cloudy ones also, ariseth to 360.

CHAP. VI.

Of the Northerne Signes of the Zodiague.

 He first is Aries the Ram, in Arabique Alhansel: this Constellation hath 13. Stars, according to Ptolomies account; yet Alfraganus reckoneth but 12. besides the other 5. unformed ones, that belong unto it.

The 2^d is Taurus, the Bull, in Arabique Altor, or Ataur: in the eye of this Constellation there is a very bright Starr, called by the Ancient Romans Palilicium, and by the Arabians Aldebaran, which is to say, A very bright Star, and also Hain Altor, that is, the Bulls eye. And those five Starrs that are in his forehead, and are called in Latine Sueula, the Grecians

Grecians call *Ursa* because, as *Theon*, and *Hero Mechanicus* conceive, they represent the forme of the Latine, *Υ*. although perhaps it is rather because they usually cause raine and stormy weather. *Thales Milesius* said that there were two of these *Hyades*, one in the Northern Hemisphere, and the other in the South: *Euripides* wil have them to be 3. *Achem* 4. *Hippius* & *Pherecides* 7. Those other 6. or, rather 7 Stars, that appeare on the backe of the Bull. the Greeks call *Pleados*, (perhaps from their multitude) the Latines *Vergilio*, the Arabians *Asawia*, quasi *Taurina*, belonging to the Bull. *Nican-*
der, and after him *Vitruvius*, and *Pliny* place these Stars in the taile of the Bull: and *Hip-*
parchus quite out of the Bull, in the left foot of *Persus*. These Stars are reported by *Pliny* and *Solinus* to be never seen at all in the Isle *Tapro-*
bana: but this is ridiculous, and fit to bee re-
ported by none, but such as *Pliny* and *Solinus*. For those that inhabite that Isle, have them almost over their heads. This Constellation hath 33 Stars in it, besides the unformed Stars belonging to it, which are 11. in number.

PONT. *Plinies words in that place do not seeme to carry any such sense simply, seeing that he addes the same also of the Bear. His words are these in his lib. 6. cap. 22. Where speaking of certain Embassadors that came from the Isle Taprobana to Rome, he saith; Septentriones, Virgiliae apud nos, veluti novo caelo, mirabantur. They wondered to see the Beare. and*
the

the seven Stars within, as if they had been armed in a new world. And certainly if Tappanone be situated under the very Line, this then, for the very reason we alledged before on the 3. chap. par. 2. out of Lælius, had been no such strange matter, if it had been spoken of the Septentriones only. Neither had Pliny written any so absurd a relation, if he had said thus. Septentriones apud nos, veluti novo cælo, mirabantur.

In the meane time I could wish, that Authors would insert nothing in their books, without due examination: although I am not ignorant, that it is not strange to find Pliny fantasizing, now and then, in these kind of things.

The third is Gemini, the Twinne, in Arabique *Algezze*. These some will have to be Cassiope and Pollux, and others, Apollo and Hercules: whence with the Arabians, the one is called *Apellor*, for a *Aphellor*; and the other *Abracadm*, for *Graclem*: as Scaliger conceiveth. It containeth in it, (besides the 7. unformed,) 18. Stars, amongst which, that which is in their head, is called in Arabique *Ras-gezz*.

The fourth is Cancer, the Crab, in Arabique *Alfartan*, consisting of 9. Stars, beside 4. unformed: of which that cloudy one, which is in the breast, and is the first of all, is called *Mel-les* in Arabique, which, as Scaliger saith, signifieth thick or well compact.

The fifth is Leo, the Lion, in Arabique *Alased*, in the breast whereof there is a very bright Star, being the 8th in number, and is called in

in Arabique *Cale Alased*, the heart of the Lyon, in Greek *βασιλεως*, because that these that are borne under this Starr, have a Kingly Nativity, saith *Proclus*. And that which is in the ende of the taile, and is the last of all in number, is named *Deneb Alased*, that is to say, the taile of the Lion: *Alfraganus* calleth it *Asumpha*. This Constellation containeth in it 27. Stars besides 8. unformed. Of the unformed Stars which are betwixt the hinder parts of the Lion, and the Great Beare. (according to *Ptolomies* account, although *Theon* following *Aratus*, reckons the same as belonging to *Virgo*,) they have made a new Constellation, which *Conon* the Mathematician, in favour of *Ptolomy* and *Berenice*, would have to be called *Berenices Haire*: which story is also celebrated by the Poët *Callimachus* in his Verses.

The sixth is *Virgo*, the Virgin, in Arabique *Eldari*: but it is more frequently called *Sunbale*, which signifieth an Eare of Corne: and that bright Star which she hath in her left hand, is called in Greek, *σείξυς*, an Eare of Corne, and in Arabique *Hazimeth Albacel*, which signifieth a handfull of Corne. This Star is wrongly placed by *Vitruvius* and *Higinus* in her right hand. The whole Constellation consisteth of 26. Stars, beside the 6. unformed.

Chap.

CHAP. V.

Of the Constellations of the Southern Hemisphere:
and first of those in the Zodiacue.



And first of *Libra*, which is the 7. in order of the Signes. that part of this Constellation which is called the Southern Ballance, the Arabians call *Mizan Aliemin*, that is to say, *Libra dextra vel meridionalis*, the Right-hand or Southern ballance. But *Libra* was not reckoned anciently among the Signes: till that the later Astronomers robbing the Scorpion of his claws, translated the same to *Libra*, and made up the number of the Signes: whence the Arabians call the Northerne ballance *Zubeneshchi mali*, that is in Greek, $\chi\eta\lambda\eta\ \beta\acute{\iota}\rho\epsilon\iota$ the North Claw, and the other part of it that looks Southward, they call *Zubenelgenubi* $\chi\eta\lambda\eta\ \gamma\acute{\epsilon}\nu\epsilon\beta\iota$, the South Claw. This Constellation containeth in it 8. Starrs, besides 9. other unformed belonging to it.

The eight is *Scorpio*, the Scorpion, in Arabique commonly called *Alatrab*, but more rightly *Alacrab*: whence the Starr in the brest of it, which is the 8. in number, is called *Kelebalacrab*, that is, the heart of the Scorpion: and that in the end of his taile, which is the second in number, they call *Lefchat*, but more truly *Lefath*, which signifieth the sting
of

of any venomous creature, & by this word they understand the Scorpions sting. It is also called *Schomlek*, which *Scaliger* thinks is read by transposition of the letters, for *Moselek*, which signifieth the bending of the taile. This Constellation consisteth of 21. Stars, besides 3. unformed.

The ninth is *Sagittarius*, the Archer, in Arabique *Elcufu*, or *Elcamfu*, which signifieth a Bow; it hath in it 31. Stars.

The tenth is *Capricornus*, the Goat, in Arabique *Algecli*. To this Constellation they attribute 28. Stars, among which that which, is in number the 23. is called in Arabique *Denob Algedi*, the taile of the Goat.

The eleventh is *Aquarius*, the Waterman, in Arabique *Eldelis*, which signifieth a Bucket to draw water. The 10. Star of this Constellation is called in Arabique *Seas*, which signifieth an Arme. It containeth in all 42. Stars.

The twelfth is *Pisces*, the Fishes, in Arabique *Alsemcha*. It containeth 34. Stars, and 4. unformed.

PONT. Among all the Constellations reckoned up by the Author in this and the precedent chapters, there are only found 5. Stars of the first Magnitude. The first of which, is *Oculus Tauri*: the second, *Cor Leonis*; the third, *Cauda Leonis*; the fourth *Spica Virginis*: and the fifth and last, is a star about the mouth of the South Fish. The rest are all either of the 2. 3. 4. 5. or 6. Magnitude, beside some certain cloudy ones; which are reckoned in all to be 346.

C H A P VI.

*Of the Constellations of the Southern Hemisphere,
which are without the Zodiack.*

THE first is *Cetus*, the Whale, called in Arabique *Elkaitos*, consisting of 22. Starrs. That which is in number the second, is commonly called *Menkar*, but more rightly, as *Scaliger* saith, *Monkar Elkaitos*, the nose or snout of the Whale: and the 14. *Boten Elkaitos*, the belly of the Whale: and the last of all save one, *Deneb Elkaitos*, the taile of the Whale.

The second is *Orion*, which the Arabians call sometimes *Asugia*, the mad-man; which name is also applied to *Hydra*: and sometimes *Elgenze*. Now *Genze* signifieth a *Wall-nut*: and perhaps they allude herein to the Latine word *Jugula*, by which name *Festus* calleth *Orion*: because he is greater then any of the other Constellations, as a *Wall-nut* is bigger then any other kind of *Nut*. The name *Elgenze* is also given to *Gemini*. This Constellation is also called in Arabique *Algibbar*, which signifies a strong man, or Gyant. It consisteth of 38. Stars, among which that which is the second, and is placed in his right shoulder, is called *Ied Algenze*, that is, *Orion's Hnda*, as *Christmannus* thinketh: but more commonly *Bed Elgenze*, and perhaps it should rather

rather be *Bet Elgenze*, that is the bright Star in *Orion*. The third Star is called by the *Al-fanfines Bellatrix*, the Warrior. That which is in his left foot, and is the 35. in number, is called *Rigel Algenze*, or *Algibbar*, that is to say, *Orion's foot*.

PONT. In the 9. cap. of *Job*. vers. 9. there is mention made of *Orion*, as we said before. Now the word in the Originall is *Kesil*, which signifieth *Madnesse*, *Rage*, and *Instability* : and it is so called perchance, because that when this Constellation riseth with the *Sun*, it causeth great store of tempestuous weather in all places : whence it is stiled by the Poets, *Nimbosus* & *Aquosus Orion*. Now we must note, that this word *Kesil* in *Hebrew*, (which is rendred *Orion* by *Hierome* and others) doth answere to the *Arabique* word *Asugia*, which signifieth likewise a *Bold* or *Furious* fellow. as our Author saith. In like manner there is mention made of *Orion* again in the 39. Chapter of *Job*, verse 13. *Nunquid cohibebis delicias Pleiadum, aut lora Orionis dissolves* : Canst thou bind the sweet influences of the *Pleiades*, or loose the bands of *Orion*? notwithstanding, *Interpreters* do not all agree in rendering this place. Look also in the Prophet *Amos*. cap. 5. ver. 8.

The third is *Eridanus*, in *Arabique* *Alvabar*, that is to say, the *River* : whence *Nar*, the name of a *River* in *Hetruria*, is conceived, by some, to have been contracted. It hath in it 34. Stars : among which that which is the 19. is commonly called in *Arabique* *Avgetenar*,

getener, but Scaliger rather thinkes it should be red *Anchenetemar*, which signifieth the winding or crooking of a River. The 29. Star is also called *Beemim*, or rather *Theemim*, which signifieth any two things joyned together: so that it is to be doubted, whether or no, this name may not be as well applied to any two Stars standing close by one another. And the the last bright Starr in the end of it, is called *Acharnahar*, as if you should say, Behind the River, or, in the end of the River and it is commonly called *Acarnar*.

PONT. Avienus calls this River Nilus, in these verses of his.

—Pharium pars altera Nilum (amne,
Commemorat, largo segetes quod nutrit
In English thus.

The other part relates of fruitfull Nile,
Whose swelling streames enrich the Pharian Ile.

And Plautus also hath an elegant Periphrasis of the same in his *Trinummus*, Scen. Huic ego, where he speaks thus: *Ad caput amnis, quod de cælo exoritur sub solio Iovis.* relating it, as of a River that should spring out in the Heavens, from under Jupiters Throne.

The sixth is *Lepus* the Hare, in Arabique *Al-arnebet*: and it containeth in all 12. Stars.

The fifth is *Canis* the Dogge, *Alchaleb A-lachbar* in Arabique, the great Dog; and *Al-suhare aliemalsja*, that is to say, the right hand or Southerne Dogge. Which name, *Al-suhare*, which is also sometime written *Scera*, Scaliger thinkes is derived from an Arabique word,

word which significeth the same that *ὀδυσσεΐα* in Greek, a disease that mad Dogs are troubled with, when as they cannot endure to come near any water. Notwithstanding *Grozis* is in doubt, whether or no it should not rather be *Elseiri*, and so derived from the Greek word *εἰς*, For by this name is that notable bright Starr called, which is in the Dogs mouth, and is called in Arabique *Gabbir*, or *Echer*, and by corruption, *Habor*. This Constellation hath in it 11. Stars.

The sixth is the little Dog, called in Greek *Procyon*, and in Latine *Antecanis*, because it riseth before the great Dog. The Arabians call it *Alcheleb Alasgar*, that is to say, the lesser Dog, and *Alisahare alfemalija*, and commonly, though corruptly, *Algomezza*, the left hand or Northern Dog. This asterisme consisteth of two Stars onely.

PONT. *There is extant a noble witty Epigram in Ausonius of the Cœlestiall, Terrestriall and Marine Dogs; which may have reference to this place also, if so be that, it be presented in it's proper meaning after this manner.*

Trinacrij quondam currentem in littoris ora
Antecanis leporem cœruleus rapuit. (ett;
At Lepus. In me omnis terræ, pelagiq; ruina,
Forti an & Dœli; ti Canis astra tenet.

In English thus.

At once a Hare came lightly tripping o're
The sandy banks of the Trinacrian shore:
A Dog fish caught her. Whereat she replies.
Land, Stars, and all, are still mine enemies

Nor should I yet be more secure, I feare,
In heaven it selfe; if dogs they harbour there,

In which place *Antecanis Cœruleus*, in the second verse, signifieth a Sea-Dog. Yet this place hitherto hath commonly gon thus, *Ante canes, lepoem, &c.* without any sense at all. Now the Poët in this place useth this word *Antecanis*, in imitation of *Tully*, who first of all Latine Authors, rendred *Procyon*, *Antecanis*: as manifestly appeareth out of his translation of *Aratus* into Latine verse.

The seventh is *Argo*: the Ship in Arabique *Alsephina*; now *Sephina* signifieth ship. It is also called *Merkeb*, which signifieth a Chariot: according as the Poëts also usually call it, *ἡ πικρὸν ὄχημα* as if one should say, a Sea-chariot, instead of a Ship. But the *Alfonsines* give this appellation to that Star which is the 6. in number. The whole *Asterisme* containeth in it 45. Stars, of all which, that which is the last save one, is called in Arabique *Sohel*, or *Syhel*, which signifieth Ponderous or weighty. Which Appellation they perhaps have given it, for the same reason, that *Bessus* hath another like it, which is, *Terrestris* because it alwayes appeareth to them very low, and neare the earth. The Greeks call this Star *γάρωβ*, the Hebrews *Chefil*, as *Christmannus* is of opinion. Which if it be so, then *Arias Montanus* is in an error, in taking it for *Orion*, in his translation of the Itinerary of *Benjamin Tudelensis*. The Inhabitants, of *Azania* called it an Horse, as *Ptolomy* affirms, in his *Geogra. lib. 5. cap. 7.* The

The eighth is *Hydra*, in Arabique *Alfugabh*, or *Asua*, which signifieth Strong, or Furious. The *Egyptinas* called it *Nilus*, as *Theon* writeth in his Commentaries upon *Aratus*. It hath in it, 25. Stars, besides two unformed: th 12. of which the *Alphonfines* call *Alphart*.

The ninth is *Crater*, the Cup, in Arabique *Albatina*, and *Elkis*, which signifieth a Goblet or standing cup. It hath in it 7 Stars.

The tenth is *Corvus*, the Crow, *Algorab* in Arabique, consisting of 7. stars.

The eleventh is *Centaurus*, the Centaure, called by the same name in Arabique. It containeth 37. Stars; among which, those that are in his hinder feet, are the Stars that make up the Crosse, so much celebrated in the Spanish Navigations.

The twelfth is *Fera*, the Wild beast, called in Arabique *Asida*, signifying a Lionesse, and *Alsubabh*, which also is taken for a Wolf; or other ravenous beast. To this Constellation they reckon 19. Stars.

The thirteenth is *Ara*, or *Thuribulum*; the Altar, or Censer, in Arabique *Almugamra*: *Bassus* called it *Sacrarium*. It containeth 7. Stars.

The foureteenth is *Corona Australis*, the South Crown, in Arabique *Alachil Algenubi*: it consisteth of 13. Stars. making up a double wreath, according to *Alfraganus*: yet *Theon* reckoneth but 12. in it.

The fifteenth is *Piscis Austrinus*, the South Fish, *Ahaut algenubi* in Arabique. It containeth

taineth in it 12. Stars in Ptolomies account but 11. onely according to *Alfraganus*. Among which the bright one that is in his mouth, is called *Phom Abut*, that is to say, the mouth of the Fish, and commonly by corruption, *Fomahant*.

There is also described in the Cœlestiall Globe a certain broad Zone or circle, of the colour of milk, which representeth that which appeareth in the Heavens, and is commonly called *Via Lactea*, the milkey way. Which Zone or circle is not drawn regularly or equally, either in respect of latitude, colour or frequency of Stars: but is different and various, both in form and situation, in some places appearing but as a single circle, and again in others seeming as it were dividing in two parts. The delineation whereof, you may see in the Globe, and the description more largely set down by *Ptolomy* in his *Almegeft*. lib. 8. cap. 2.

PONT. This part of the Heavens hath in it 7. Stars of the first Magnitude, whereof the first is in the right shoulder of *Orion*: the second, in his left foot: the third, in the end of the River *Eridanus*; the fourth, in the mouth of the great Dog, which they call *Sirius*: the fifth, in the thigh of the Little Dog, called *Procyon*: the sixth, is *Canobus*, in the ship *Argo*: and the seventh is in the right foot of the *Centaure*. To which we may add of the second magnitude, 18. of the third, 60. of the fourth, 168. of the fifth, 53. of the sixth, 9, and one cloudy one. All which are in the generall, 316.

Now

Now the whole Firmament, reckoning in the Northern and Southern Hemispheres together with the Zodiacque, containeth in all 1022. Stars, which make up 48. Asterismes or Constellations. Neither did either Ptolomy, or Hipparchus before him, know any more then these. Notwithstanding Pliny, as our Author hath advertised before in the second Chapter, made the number of Stars and Constellations a great deal larger. But of this wee shall speake more in the end of the next Chapter. And concerning those Constellations, which have been more lately observed about the South Pole by the Portugals and Hollanders. and by them named, we intend to speak something in the end of the Chapter following.

CHAP. VII.

Of the Starrs which are not expressed in the Globe.

BESIDES these Stars which wee have here reckoned up out of Ptolomy, there are yet many other to be seen sometime, especially in the winter time, in a cleare night, when as there are both many more Stars to be seen, then at other times, and those that are seen, appeare by much greater. Now if you expect that we should assigne the cause of this: we might answer, that it is besides the intention of our present purpose. Yet for your satisfaction, and because that some Authors have very

much erred from the right, In setting down the true reason of the same : we doe therefore the more willingly make this digression. For some there are, who (out of the extraordinary knowledge they have in Phylosophy, and Optickes) would very willingly perswade us, that either we conceive them to be more, then indeed they are, and that our sense onely is deceived: or else (which is altogether as ridiculous) that the aire being in winter more pure and thin, making them more conspicuous, which otherwise in the Summer, when the ayre is more grosse, do altogether lye hid. And this is an error which I do not so much blame in others as I wonder at it, in *Johannes de Benedictis* : that so great a Mathematician, as he is held to be, should be led away with so grosse an error. For the reason of this is altogether otherwise, and cleane contrary. For, for that very cause that the aire is more grosse and thick, the Stars therefore do appeare more, and greater. Which opinion of ours is confirmed, both out of principalls of the Opticks, and also by the sense of it selfe, experience, and authority of learned writers.

For first, that the raies being refracted through a grosse *Medium*, and diffused, as it were, in certain Canales, do represent the image of the object greater then indeed it is, is plainly affirmed (and that according to the doctrine of the Optickes) by *Strabo* himself out of *Pofidonius*. And that through *Perspicills*

cills or Spectacles, things appeare more, and greater then otherwise they would, is a thing well known to the most Ignorant. *Cleomedes* also saith, that the Sun being seen by any in the bottom of a deep Well, seemes greater, then when he is seen from above: and that by reason of the moistnes and grosse-nesse of the ayre in the bottom of the Well. And if it were possible to see the Sun through stone walls, or other solid bodies, (as the old Poëts fabulously report of *Lyncæus*;) he would seem much bigger then he is; as *Posidonius* rightly teacheth. And hence is it, (saith *Strabo*) that we see the Sun alwaies greater at his rising and setting, especially to those that are at Sea. Yet wee doe not say that he appeares ten times greater then hee is, as it is reported he doth in *India*, out of the Excerpts of *Etesias* his *Indian* Histories: much lesse, that he seemes to be an hundred times greater then he is in other places, as he is feigned by *Artemidorus* to bee at his setting, to those that inhabit a Promontory in the outmost parts of *Spain*, which he calls *Promontorium Sacrum*: but is justly taxed for the same by *Posidonius*. *Alfraganus* would have the cause of this to be, for that the vapours which are exhaled out of the earth, and elevated into the ayre, and so interposed betwixt our sight and the Sun, at his rising or setting, doe make him appeare greater then hee is. The same is the opinion of *Strabo* and *Cleomedes* also, out of *Posidonius*: neither doth

this differ much from the opinion of the best of our Opticall Writers. But of this enough.

There are also observed many Stars in the Southern parts of the world: which because they could not be seen by our Artists in these parts of the World, we have therefore no certain knowledg left us concerning the same. So in like manner, among those which we have hitherto spoken of, many of them cannot be seen by those that inhabit any whit neare the North Pole. But concerning those Stars that appeare about the South Pole of the World, I will here set you down a very admirable story, which *Franciscus Patricius Senensis* relateth in the end of his *Nova Philosophia*, out of the Navigations of *Americus Vesputius*. And it is thus. *Cælum decentissimè exornatur, &c.* The Heavens (saith he, meaning about the Antarticque Pole) is variously adorned with divers Constellations, which cannot be seen here with us: among which I do very well remember that I reckoned very neare twenty, which were as faire and bright as *Venus*, and *Jupiter* here with us. and a little after he saith. I was certain therefore, that these Stars were of greater magnitude, then any man can conceive: and especially three *Canobi*, which I saw, and observed; two whereof were very bright ones, but the third was somewhat obscure, and nothing like the rest.

And a little after, he proceeds. But the Pole it selfe is encompassed about with three Stars

Stars, which represent the figure of a right-angled Triangle: among which, that which is in the midst, is in circumference, 9. gr. and a halfe: and when these rise, there appeares, on the left hand of them, another bright *Canopus* of notable magnitudo.

And a little after, he saith. After these there follow three other very faire Stars, the middlemost of which hath in Diameter 12. degrees and an halfe; and in the midst among these, there is seen another *Canopus*. After this there follows 6. other bright Stars which excell all the other Stars, in the eighth Sphære for brightnesse: the middlemost of them, having 32. gr. in Diameter. These Stars are accompanied by another greater, but darker *Canopus*: all which Stars are observed in the Milky way.

To this he addeth, out of *Corsalius*, his that followeth. *Andreas Corsalius* also affirmeth, that there are two clouds, of a reasonable brightnesse, appearing near the Pole; betwixt which there is a Star distant from the Pole, about a 11 gr. over which, he saith; there is seen a very admirable figure of a Crosse, standing in the midst of 5. Stars that compasse it about, with some certain others that moue round about it, being distant from the Pole, about 30. degrees: which are of so great brightnesse, as that no Signe in the Heavens may be compared with them.

And now, that you have heard this so strang and admirable relation of the Stars about the
Antarctique

Antarctique Pole, *Audium admissi risum teneatis?* For *Vesputius* hath here forged three *Canobi*, whereas *Ptolomy*, and all the Ancient Greekes never knew but one, and that is it which is placed in the stearne of the ship *Argo*, And here it is very well worth our noting, that *Patricius* (as far as I am able to gather out of his writings) out of *Vesputius* his ill expressed language, and by him worse understood, hath very excellently framed to himself a strange kind of Star, that hath in apparent Diameter; 32. degrees: whereas the Diameter of the Sun it self hardly attaineth to 32. minutes.

But those things which out of our owne certain knowledg and experience in above a years voyage on Sea, in the yeares, 1591. and 1592. we have observed beyond the Æquator, and about the Southern parts of the world, we will here set down.

Now therefore, there are but three Stars of the first magnitude that I could perceive, in all those parts, which are never seen here in England. All which, notwithstanding, *Ptolomy* saw, in *Alexandria* in *Egypt*. The first of these is that bright Star in the stearn of *Argo*, which they call *Canopus*. The second is in the end of *Eridanus*. The third is in the right foot of the *Centaur*. To which if you will add for a fourth, that which is fixed in the *Centaur*s left knee, I shall not much stand against it. But other Stars of the first magnitude, then these which I have named, that part of the world

world canot shew us. Neither is there to be found scarcely two or three at the most, of the second magnitude, but what *Ptolomy* had seen, and indeed there is no part of the whole Heavens, that hath so few Starrs in it, and those of so small light, as this neare about the *Antarctique Pole*. We had a sight also of those Clouds *Andreas Corsalius* speakes of, the one of them being almost twice or thrice as big as the other, and in colour, something like the *Vsa Lactea*, and neither of them very farr distant from the Pole. Our Mariners use to call them *Mazellanes Clouds*. And wee saw also that strange and admirable Crosse which he talkes of, which the *Spaniard* call *Cruzero*, and our Countriemen, the *Cruisers*. And the Stars of which this Crosse consists, were not unknown to *Ptolomy* also; for they are no other, then the bright Stars which are in the *Centaurus* feet. All which things I did the more diligently and oftener observe, for that I remembered that I had read in *Cardan* also, strange relations of the wonderfull magnitude of the Stars about the South Pole, not unlike the stories he have now alledged out of *Patricius*.

PONT. *The names of the Constellations of the Southerne Hemisphere as they have been now lately observed, and named by the Portugals and others, are these. The South Triangle: the Crane; the Phœnix; the Water Serpent; the Dorado, or Gilthead fish, situated in the very Pole of the Ecliptique; the Chamæleon*
with

with the flye; the Flying Fish; the Bird of Paradise; the Peacock; the naked Indian; the bird Toucan, or Brasilian Pye. All which are accurately portraited in the Globes set fourth by Hondius. Among all these there are no Stars, of the first Magnitude, but of the 2. seven: of the 3. six: of the 4. thirty five: of the 5. fifty six: of the 6. eleven: with six unformed, and two cloudy Stars, besides the two cloudes themselves. Now, the whole number of the Stars in this Southerne part, beside the cloudy ones, is 121, which being added to 1022. the whole sum will be 1143. Of which, 1022. were reckoned before, by our author, out of Ptolomy onely there is a scruple cast in our way by those words of Pliny, in his lib. 2. cap. 41. *Patrocinaur vastitas cœli &c.* And this opinion (sa. th. be) is seconde also by the vastnesse and immensity of the Heavens. which is distinguished into 72. Signes, all which are the resemblances either of living creatures, or other things, according as they have been reduced into method and order by the skilfull in those Arts. Among which Constellations. They have observed 1600. Stars, all which are notable either in their effects or magnitude. Where wee see that hee accounteth the whole number of the Stars to be 1600 whereas Ptolomy. after him acknowledged only 1022. So likewise he reckoneth the Signes or Asterismes to be in all 72. which yet in Hipparchus, Eudexus, and Ptolomies account, are but 48.

Scaliger in his Commentaries upon Manilius, pag 67. that he might untie this knot, reads these
w. r. d. s

words of Pliny thus. *Patrocinator vastitas coeli, immensa altitudine, discreta in duo de L:signa, &c.* Where, for seventy two, he would have it to be wanting two: which is 48. the just number reckoned by Ptolomy. But yet the same doubt still remains in the ensuing words, where he maketh the whole number of the Stars to be 1600.

I find also two other Signes added to the former Southern Constellations, which are Noah's Dove, and the Phœnicopter. The first of which containeth in it, 11. Stars: of which there are two in the back of it, of the second magnitude, which they call the Good messengers, or bringers of good newes: and those in the right wing are consecrated to the Appealed Deity, and those in the left, to the Retiring of the Waters in the time of the Deluge.

The Phœnicopter we may call the Bitton. Of this bird, Martiall hath an Epigram, lib. 13.

Dat mihi penna rubens nomen, sed lingua
gu'osia
Nostra placet. Quid si garrula lingua foret?


The Spaniards call it Flamengo: and it is described with the wings spread abroad and as it were striking with his bill at the South Fish, in that part where he boweth himself. This Asterisme consisteth of 13 Stars: in which that of the second magnitude in his head, is called the Phœnicopters Eye: and it hath two other Stars also of the same magnitude, one in his back, and the other in his left wing. And those two which are in the middle of his neck. Paulus
M: rula

Merula in his first book of his Cosmography, collecth his Collar or Chaine.

Lastly we are to take notice that the Indians call the south Pole, Dramasia : for so Pliny testifieth in his lib. 6. cap. 19. Austrinum Polum Indi Drammasa vocant.



The



The third Part,

CHAP. I.

*Of the Geographicall description of the Terrestriall
Globe; and the parts of the world yet known.*



Dionysius Afer, in the beginning of his *Periegesis*, saith, that the whole Earth may be said to be, as it were, a certain vast Island, encompassed about on every side with the Ocean. The same was the opinion of *Homer* also before him, and of *Eratosthenes* (whom *Dionysius* is observed by *Enstathius*, his Scholiast, to follow in many things) as is witnessed by *Strabo*. The same is affirmed by *Mela* also after him. This vast Island of the whole Earth they would have to be terminated on the North side, with the frozen Sea, which is called by *Dionysius* *Mare Saturninum*, and *Mortuum*: on the East, with the Eastern Sea, which is also called *Mare Sericum*: on the South, with the Red Sea, (which *Ptolomy* calleth the Indian Sea) and The *Æthiopian*: and on the West, with the *Atlantick* Ocean. Out of this Ocean also, there

there are foure particular gulfes (as the Ancient Geographers conceived) which embosomed themselves into the maine land. Two of which derived their course out of the *Erythraean* or Red Sea, to wit, the *Persian* and *Arabian* gulfes. From the West, there is sent out of the Atlantick Ocean a vast gulf, which is called the *Mediterranean* Sea. And out of the North, they would have the *Scythian* Ocean to send in the *Caspian* Sea, which is shut in, almost on every side, with high craggy rocks; from whence the streames flow with such violence, that when they are come to the very fall, they cast forth their water so farr into the Sea, without so much as once touching upon the shore, that the ground is left dry and passable for whole Armies, under the banks; the streames in the meane time being carried over their heades; as it is reported by *Eudoxus* in *Strabo*. This Sea both *Strabo*, *Pliny*, *Mela*, and *Solinus*, will have to come out of the *Scythian* Ocean, (as we have said) But this errour, of theirs besides the experience of these later times, is manifestly convinced by this one testimony of Antiquity: which is, that the water of this Sea is found to be fresh and sweet, as was first observed by *Alexander the Great*, and afterwards by *Pompey*, as *Me. Varro* in *Solinus* testifieth, who at that time himselfe served under *Pompey* in his Wars. And this is the chiefeft reason which *Polycletus* in *Strabo* alledged, for the prooffe of the same.

Now all this tract of land the Ancients divided

vided at first into two parts only, namely, *Asia*, and *Europe*: to which, succeeding times added a third, which they call *Africa*, and sometimes also *Lybia*. And of these, *Asia* is the greatest, *Africa* the next, but *Europe* the last of all: according as *Ptolomy* determines it, in the 7. book of his Geography.

Europe, is divided on the East from *Asia* by the *Aegean* Sea (which is now called the *Archipelago*) and the *Euxine* Sea, which was at first (as *Strato* in *Strabo* thought) encompassed about on all sides in manner of a great lake, till at last by the great accession of other Rivers and waters, it so far increased, as that the banks being unable to containe it, it violently made it's way into the *Propontis* and the *Hellepont*. The *Euxine* Sea, is now called *Mare Maggiore*. It is also bounded on the same side, by the like of *Maotis* (now called *Mare delle Zabacchi*) the River *Tanaïs*, (commonly called *Dón*) and the Meridian, which extends it selfe from thence to the *Scythian* or *Frozen* Sea. On all other sides it is encompassed with the Sea. For toward the South it is divided from *Africa*, by the Straits of *Gibraltar*, and part of the *Mediterranean* Sea. (The length of these Straits is according to *Strabo*, and *Pliny* 120. furlongs: and the bredth of it, according to the same *Strabo*, 70. furlongt. But *Mela* would have it to be 10. miles, that is to say, 80. Furlongs. T. *Livius*, and *Cornelius Nepos*, make the latitude of it to be, in the broadest

L place,

place, 10. miles, or 80. furlongs; and where it is narrowest, 7. miles, or 56. furlongs. But *Turannius Gracula*, who as *Pliny* reports, was borne about those parts, accounted it to be from *Mellaria*, a town in *Spaine*, unto that Promontory in *Africa*, which is called *Promontorium Album*, but 5. miles in all, that is, 40. Furlongs. *Eratosthenes* was of opinion, that *Europe* was sometime joyned to the Continent of *Africa*. and it is reported by *Pliny*, that the inhabitants of those parts have a Tradition, that the *Isthmus*, or neck of the land by which *Europe* and *Africa* were joyned together, was cut through by *Hercules*.

Europe, is terminated on the West with the Atlantick Ocean: and on the North with the British, Germane, and frozen Seas.

PONT. This Northern part of *Europe* began first to be discovered and known to the world, in the reign, or rather through the meanes, and by the direction of *Augustus Cæsar*. For as *Pliny* saith, lib. 2. cap. 76. *Septentrionalis Oceanus, majore ex parte navigatus est, &c.* The Northern Ocean for the greatest part was first searched by *Augustus Cæsar*, who sent forth a Navy, which passing all along the Coasts of *Germany*, came so far as the Promontory of the *Cimbrians*, and thence passing on through a vast Sea, which they had only heard of, before, they went as far as the Coasts of *Scythia*. In which place, *Pliny* meaneth those Sea expeditions, performed by *Tiberius*, and *Drusus Germanicus*: but especially that of *Drusus*, as may appeare by these

these words of Tacitus, where he saith thus. *Ipsam quin etiam Oceanum illa tentavimus, &c.* Wee left not the Ocean unattempted that way also, and it is a common faine, that Hercules Pillars are yet remaining; whether it be true indeed, that Hercules ever went so far, or else, that what ever Magnificent thing is any where to be found, we all conspire unanimously to honour him therewith. Neither was there wanting courage for the attempt to Drusus Germanicus: only the Ocean would not suffer it self, nor Hercules, to be farther inquired into. After this no man attempted it: and it was thought a greater point of reverence and religion, to believe the Actions of the gods, then to know them. Thus he.

Now before this time, all this tract of land lying towards the North, the Romans called *Novus Orbis, Ignotus Orbis*, the new and unknown world: as I remember I have seen it, in a certain Elegy of Albinovus upon the death of the same Divus. And the Promontory of the Cimbrians, which Plinev speakes of, is now called Scagen, and is the most northern point of Denmarke.

And as concerning these Pillars of Hercules, mentioned by Tacitus; Hadrianus Junius who sometimes saw these coasts, referreth the same to that high rock or Promontory in Scandinavia (Junius hath it Norvegia, but not rightly) which is at this day called Col, both by the Natives, and our Mariners also. For in this place they have a superstitious custome, that as Strabo reportes of the Gaditane Pillars, when any ships had arrived there, as if they had attained the

end of their labours and travaile, they forthwith sacrificed to Hercules : in like manner in this place they have a custome , that if they have fresh men that never sailed those Northern Seas before , they have certain Ceremonies with which they use to make them free of the Sea, (as I my self once saw done sailing by this Promontory) for they tack and bind them to the Mast of the ship and then taking the scoope, and filling it with Sea water, they make as it were a Libation, pouring it upon their heads, which done, they are forthwith exiated, and accounted free of the place. But whereas Junius would have the word Col, to be only corrupted from Columna, I much doubt whether he will have any more of his opinion But of this place, as also of all this Northern tract of land, I shall have a more convenient opportunity to speak elsewhere.

Africa, is divided from Asia, according to Dionysius and Mela by the River Nilus, and a Meridian drawn through it , to the Æthiopian Ocean, But Ptolemy, would rather have its limets on this part to be the Arabian gulse, (which he not so rightly calleth the Red Sea, and a Meridian, which should bee drawn from thence to the Mediterranean Sea, over that neck of Land which lyeth betwixt the two Seas, and which joyneth Ægypt to the Continent of Arabia and Indea. Neither doth he think it congruous,, that Ægypt should be divided into two parts, one whereof should be reckoned to Africke, and the other to Asia: which must needs be, if the River Nilus be let
for

for the bounds of the same. Neither doth *Strabo* conceive this to be any whit improper, since that the length of this *Isthmus*, which divideth the two Seas, is not above 1000. furlongs. And hee seemeth to have said very rightly, that it is not above a 1000. furlongs. For however *Posidonius* reckoneth it to bee very near 1500. furlongs: yet *Pliny* would have it to be no more then 115. miles, that is to say, 920. furlongs. And *Strabo* also reckoneth the distance betwixt *Pelusium* and the *Heroes* City, which is situated close by the highest part of the Arabian Gulf, to be but 900. Furlongs. But if we will give any credit to *Plutarch*, at the narrowest part of the *Isthmus*, the two Seas wil be found to be distant not above 300. furlongs. And that, (when *Anthony* was overthrown by *Augustus* in a Sea fight, and all his forces cleane broken,) *Cleopatra*, seeking to avoid the servitude of the Romans, went about to transport her Navie this way over the firme Land, that so she might find some new place of habitation, as farr remote from the Romans as she might: as it is reported by the same Author, in the life of *Anthony*. But what should move *Copernicus*, In his first Book, 3. Cap. to say that these two Seas are scarcely 15. furlongs distant; I cannot conjecture; unlesse I should think the place to bee corrupted, through the negligence of the Transcribers, or Printers. And yet I could wish, that this, (though it be a very great one,) were all the errors that were to bee found in the writings

ings of that most excellent man.

This *Isthmus*, as *Eratosthenes* conceived, was anciently covered all over with waters, til such time as the Atlantick Ocean had intercourse with the Mediterranean: and some of the old Grammarians, Scoliasts on *Homer*, doe affirm, (as *Strabo* testifieth) that it was this way, that *Menelaus* in *Homer*, sailed to the *Æthiopians*. I wil therefore here set down some few things, which may seem to make for the confirmation of this relation, (whether you will call it an History, or rather a Fable, or Conjecture) of *Eratosthenes*:

First therefore that *Egypt*, (if not all of it) yet at least that part of it, which is situated beneath *Delta*, and is called *Egyptus Inferior*, the lower *Egypt*, and is accounted to be the gulf of *Nilus* (or rather the Sea) was made by the aggestion and gathering together of mud and land; was the conjecture of *Herodotus*, long before *Strabo*. In like manner, that the Island *Pharos*, which in *Plinies* time was joyned to *Alexandria* by a bridge, as himself testifieth, lib. 5. cap. 31. (and therefore, for this reason may seem to have been called a Peninsula by *Strabo*) was anciently distant from *Egypt* a whole day and nights saile, is reported both by *Pliny* and *Solinus*, out of *Homer*. And this is the reason as *Strabo* conjectures, that *Homer*, (whereas hee makes often mention of *Thebes* in *Egypt*) yet speaks not one word of *Memphis*: and that either because at that time it was a very smal place
or,

or else perhaps was not as yet in being, the land being in *Homers* time covered all over with water, where *Memphis* was afterward built. And this seemes also to be confirmed by the great depression and lownesse of the intermediate shore betwixt the two Seas; which is so great, that when *Sesostris* first had an intent of cutting a channell betwixt the two Seas, as was afterward intended also by *Darius*, and lastly, by *Ptolomy*; they were all forced, for this reason, to desist from their enterprise. And indeed *Strabo* reports that himself saw the *Egyptian* shore, in his time, all overflowed, beyond the Mountaine *Casius*. Besides, the great retiring of the waters at an ebbe, as well in the Arabian gulf, as in the Persian, seeme somewhat to confirme this conjecture of *Eratoſthenes*. For the tides withdrew themselves so far back in the Arabian gulfe: that *Julius Scaliger* makes mention of some Cavillers, that, for this very reason went about to derogate from the miraculous passage of the Children of *Israel* for the space of above 600. miles through the red Sea: as if they had watched their time, when the tide gave way: and that when it returned again, the *Egyptians* were overtaken therewith and all drowned.

PON T. This Sea is alwaies rendered by the *Septuagint*, *Erythræum*; and by *St. Hierom*, *Rubrum*: but the *Hebrew* text it self, understanding this gulfe of the Sea (which is called also by *Ptolomy*, *Sinus Arabicus*) calleth it *Mare*

Suph; which is as much as to say, Mare algosum, seu caricosum, because it bringeth forth great store of Alga, and Sea weeds. Which is observed also by Pliny lib. 13. cap. 25. where he saith. Nascuntur & in mari frutices, &c. There are also bred shrubs in the Sea, and in our Sea, little trees also. For the Red Sea, and all the Eastern Ocean is full of trees. For no other Language hath a proper word to expresse that which the Greeks call $\phi\upsilon\chi\epsilon$ because that Alga is more usually taken for the name of an herb, but in this place it signifieth a shrub. Thus Pliny. You may also see Strabo, lib. 16. That place which the Author citeth out of Scaliger, is in his 35. Exercitation against Cardan. And I thinke it not a misse to heare him speakeing in his owne words, that so it may appeare what his judgement is of that which is objected by those Cavillers. His words are these. In plaga Indica secundum Gangis atque Indi fauces magnus est aestus, &c. About the coast of India (saith hee) where the Rivers Ganges and Indus, disburthen themselves into the Sea, there are very high tides: So likewise in the Red Sea, they are so great, as that the contemners of Holy Writers have impiously forged that Moses, when he led the Israelites out of Egypt, took the opportunity of the Waters, retiring after the Tide. Which notwithstanding could not possibly be, because that as farr as Sues, which is situated in the innermost corner of the gulf, the Sea covereth the very shore; neither, when it ebbeth, doth it ever leave the ground so bare, as that the lower parts, through which the Israelites

Israelites passed, should be free from passage on foot.

And it is reported by *Pliny*, that *Numénus*, Generall to *Antiochus*; fighting against the Persians, neare the mouth of the Persian gulse, not farr from the Promontory called *Maca-vum*, got the victory of them twice in one day, first by a Sea combat: and afterward (the waters having left the place dry) on horseback: as it is related by him in his 6. book, 28. cap.

And thus much concerning *Eratosthenes* his conjecture. Let us now return to the bounds of *Africa*. Which is divided (as wee have already said) on the East from *Asia*, by a Meridian drawn through the Arabian gulse to the Mediterranean Sea. On all other sides it is encompassed about with the Sea: as on the West, with the Atlantick; on the South with the *Æthiopian* Ocean; and on the North, by the Mediterranean, which is alio the Southern bound of *Europe*.

Now as concerning *Ptolemies* ignorance of the Southern parts of *Africa*, making it a continent and contiguous to *Asia* by a certain unknown Land, which hee would have to encompass about the South side of the *Indian* Sea, and the *Æthiopian* gulf: if it bee not sufficiently evinced out of the relations of the Ancients; as namely of *Herodotus*, who reporteth, that certain men were sent forth by *Darius* by Sea, who sailed about all this tract: nor yet of *Heracledes Ponticus*, who relates a story

story of a certain Magician that came from Gelon, who said that he had compassed about all those coasts: (because *Posidonius* accounteth not these relations of credit enough to conclude any thing against *Polybius*: neither doth he approve of that story of one *Endoxus Cyzicenus*, reported by *Strabo*, *Pliny*, and *Mela*, out of *Cornelius Nepos*, an Author of very good esteem, (and that because *Strabo* thought this relation to deserve no more credit, then those fabulous narrations of *Pytheas*, *Evemerus*, and *Antiphanes*: nor lastly, those traditions of King *Juba* concerning the same matter, related by *Solinus*: Howsoever, I say, that those Traditions of the Ancients do not convince *Ptolomy* of ignorance: yet certainly the later Navigations of the *Portugals* most evidently demonstrate the same, who touching upon the outmost point of all *Africa*, which they now call, the *Cape of good hope*, passe on as far as the *East Indies*. I shall not, in the meane time, need to speak at all of that other story which *Pliny* hath: how that at what time *C. Cesar*, Son to *Augustus*, was Proconsul in *Arabia*, there were certain Ensignes found in the *Arabian gulf*, which were known to be some of those, that were cast away in a shipwrack of the *Spanish Navy*: and that *Carthage* at that time being in her height of power, *Hanno* a *Carthaginian* sailed about from *Gades*, as far as *Arabia*, who also afterward himself wrote the story of that navigation.

Africa

Asia, lyeth Eastward both from *Europe*, and *Africa*, and is divided from them, by these bounds and limits which we have already set down. On all other parts it is kept in by the Ocean: On the North by the *Hyperborean* or Frozen Sea: on the East, by the *Tartarian* and *Eastern Ocean*: on the South, by the *Indian* and *Red Sea*. But *Ptolomy* would have the Northern parts of *Asia*, as also of *Europe*, to be encompassed, not with any Sea, but with a certain unknown Land: which is still the opinion of some of our later writers, who think that Country, which we call *Greenland*, to be part of the *Indian Continent*. But we have very good reason to suspect the truth of this their opinion; since that so many Sea-voyages of our owne country-men, who have gone far within the *Arctique Circle*, beyond the utmost part, of *Norway*, and into that cold frozen Channell, that divides *Nova Zemla* from *Russia*: do sufficiently testifie, that all those parts are encompassed with the Sea. Not to speak any thing of that which *Mela* alleadgeth out of *Cornelius Nepos*, how that when *Q. Matellus Cesar* was *Proconsul* in *Gallia*, there were presented him by the King of *Suevia*, certain *Indians*, who having been severed by force of tempests from the *Indian shore*, had been brought about by the violence of the windes as far as *Germany*. Neither will I here mention that other relation of *Patrocles*, in *Strabo*: who affirmed, that it was possible to saile

saile to India, all along the Sea shore a great
 Ideal more Northward then the *Bactrians*,
Hircania, and the *Caspian Sea* : now *Patrocles*
 was made governor of these place. Nor lastly,
 that which *Pliny* himself reporteth, how that
 all this Eastern coast, from India as farr as to
 the *Caspian Sea*, was sailed through by the Ma-
 cedonian Armies, in the reign of *Selenchus* and
Antiochus.

Concerning the quantity of the Earth,
 which was inhabited, there was great diver-
 sity of opinions among the ancient. *Ptolomy*
 defined the longitude of it to be, from West to
 East, beginning at the Meridian which pass-
 eth through the fortunate Islands, and ending
 at that which is drawn through the Metro-
 polis of the *Sina*, or Chineans countrey. So
 that it should contain halfe the *Æquator*,
 which is 180 degrees, and 12. *Æquinocti-*
all houres, or 90000. furlongs measured by
 the *Æquator*. And he determined the bounds
 of the Latitude to be, toward the South, that
 Parrallel which lyeth 16.gr. 25.m. Southward
 of the *Æquator* : and the Northern limets
 he made that Parallel which passeth through
Thule or Iseland, being distant from the *Æ-*
quinoctiall 63. degrees. So that the whole
 Latitude of it containeth in all, 79. gr. 25. m.
 or 80. whole degrees, which is neare upon
 40000. furlongs. The extent of it therefore
 from East to West, is longer, then it is from
 North to South, under the *Æquinoctiall*, some-
 thing then more by halfe as much, and under
 the

the most Northern Parallel, almost by a fiftieth part. Good reason therefore had the Ancient Geographers, as *Ptolomy* conceiveth in his *lib. 1. cap. 6. Geograph.* to call the extent of it from West to East, the Longitude of it; and from North to South, the Latitude. *Strabo* also acknowledgeth the Latitude with *Ptolomy*, to be 180. degrees in the *Æquator*, as likewise *Hipparchus* doth also: notwithstanding there is some difference betwixt them, in the number of the furlongs. For these last have set down the Longitude to be of 126000. furlongs under the *Æquator*: herein following *Eratosthenes*, who reckoneth 700. furlongs to a degree. But *Strabo* maketh a Latitude a great deale lesse; that is, something lesse then 30000. furlongs: and hee bounded it on the South with the Parallel, drawn through *Cinamomifera*, which is distant Northward from the *Æquator* 8800. furlongs; and on the North with that Parallel, which passeth through these parts which are 4000. furlongs, or thereabout, more Northward then *Britaine*. And this Parallel that passeth through the Region called *Cinamomifera*, *Strabo* makes to be more Southward then *Taprobane*, or at least, to passe through the most Southern parts of the same. But herein he betrayeth his own notable ignorance; for as much, as the most Southern part of this Island, is extended farr beyond the *Æquator*; as both *Ptolomy* affirmeth in his *Geography, lib. 7 cap. 4.* and is further confirmed by the late Navigations of the *Portugals*.

gais. But *Dionysius Afer* is much farther out of the way then so : for he placeth *Taprobane* under the Tropick of *Cancer*.

And these were the bounds wherewith the Ancient Geographers terminated the then inhabited parts of the world. But in these riper times of ours, by the industry at Sea, both of the Spaniards, English, and others, the Maritime coasts of *Africa* have been more thoroughly discovered, to above 35. gr. of Southern Latitude : and the Northern limits of *Europe* have now been searched into, as far as the 73. degree of Northern Latitude, far within the Arctick circle : besides all that which hath at length been discovered in the New World, beyond the hope or opinion of any of the Ancients, the name of it being not so much as known to them.

America, which for it's spaciousness, may well be called, The other World, extending it self beyond 52. gr. of Southern Latitude, is there bounded with the Straites of Magellane: and toward the North it runeth farr within the Arctique circle : on which side also that it is bounded by the Sea, the many Navigations of our Country-men into these parts, do give strong arguments of hope. I shal not here speak of those Sea coasts, which are beyond that Sea that encompasseth about the most Northern parts of *Europe* and *Asia* ; as haveing been but onely seen afarr off as yet, and not thoroughly discovered Nor yet those other, which are more Southern, then the Indian and Red Sea :

Sea: which as yet we have not any experience to the contrary, but that wee may believe to bee one continent with those other Southern Lands, that lye beyond the Straits of Magellane.

Europe, (whether so called from *Europa Tyria*, daughter of *Agenor*, as some think; or *Phoenix*, as *Herodotus* will have it; or else from *Europa* a Sea Nymph, according to the opinion of *Hippias* in *Enstatius*; or else from *Europus*, as *Nicias* in the same *Enstatius* would have it to be; containeth in it these principall regions: to wit, Spain, France, Italy, Germanie, Bohemia, Prussia, Rhætia, Liuania, Sclavonia, Greece, Hungary, Polonia, Moscovia. or Russia, Norway, Sweden, and Denmark. To these we may add the principall Islands, as namely, those of great Britaine, the chiefe of which is England, and Scotland, enobled chiefly by being united to the English Crown: as also Ireland, which is, in like manner, subject to the same. Besides the Azores, and many other Islands scattered up and downe in the Mediterranean Sea, as Sicily, Sardinia, Crete, &c.

P O N T. In Europe these things are chiefly observable. 1. The most famous Monarchies which are in it; as namely the Emperour of Germany, the Kings of Spain, France, Great Britaine, Denmarke, Swethland, Polonia, and Moscovia. To which we may add the Pope of Rome, who, though he usurpe not the title of a King, yet is his power no whit inferiour to theirs: as also the great
In k,

Turke, who at this day possesseth a great part of *Europe* also. 2. The principall hills, which are the *Alps*, dividing *Italy* from *Germany* and *France*; and also the *Pyrenean Hills*, severing *Spain* from *France*. 3. The notable Rivers, as the *Danow*, the *Rheine*, the *Elue*, the *Weissell*, *Boristhenes*, and *Tanais*, now called *Don*. To which we may adde the River *Tagus* in *Spain*, the *Rhene* and *Garonne* in *France*, and *Thames* in *England*. Lastly, the principall commodities in *Europe*, are *Gold*, *Silver*, *Tin*, *Lead*, *Iron*, *Oyle*, all kind of graine, *Flax*, *Wool*, *Salt*, &c.

Africa, (whether it be so called from *Apher*, one of *Hercules* his companions, in his expedition against *Gerion*; according to *Eustathius*: or else from one *Iphricus*, a certain King of the *Arabians*; whence also it is called in Arabick *Iphricia*, as *Johannes Leo* testifieth: or lasty from it's scorching heat, as if it should be called ἀσπρη *quasi sine frigore*, as some are pleased to derive it:) hath in it these principal regions. First of all, next to the Straits of *Gibraltar*, (anciently called *Fretum Gaditanum*) there lyeth *Barbary*. heretofore called *Mauritania*; which containeth in it the kingdomes of *Morocco*, *Fex*, *Algier*, and *Tunis*. Next to *Barbary* lyeth *Aegypt*, which also bordereth upon the *Mediterranean Sea*. Now within *Barbary* toward the continent, there lyeth *Biledulgerid* known to the Ancients by the name of *Numidia*. The 3^d is that part which is called by the Greeks and Latines *Lybia*: but the *Arabians* name it *Sarra*. After this followen the country

try of the Negroes, so called becaute they border upon the River *Niger*, or else from their colour, This Country is now usually called *Senaga*: and it hath in it many petty Kingdomes, as namely, *Gualata*, *Guinea*, *Melli*, *Tombatum*, *Gagos*, *Guberis*, *Agades*, *Canos*, *Casena*, *Zegzaga*, *Zanfara*, *Burnum*, *Gaoga*, *Nubia*, &c. Next to these is the spacious Territory of the King of the *Æthiopians*, (who is also called *Pretegiari*, and corruptly *Prester John*) which Kingdom is famous for the long continuance of the Christian Religion in it, which hath been kept amongst them in a continuall succession, ever since the Apostles time. These Christians are commonly called *Abyssines*, but more rightly *Habassines*, as *Arias Montanus* observeth in the *Itinerary* of *Benjamin Tudelesis*. Their dominion was anciently extended very far through *Asia* also. There have bordering on the West some few obscure kingdoms, as *Manicongo*, and *D' Angola*: and toward the East and South, *Melinde*, *Quiloa*, *Mozambique*, and *Benamatapa*. The chiefe Islands that are situate neare it, are *Madagascur*, the *Canary Islands*, the *Isles of Cape Verd*, and *S. Thomas Island*, lying directly under the *Equator*.

PONT. Africa, both these things in it considerable. 1. It is greater then *Europe*. but lesse then *Asia*, and lesse inhabited, and civilized then either. 2, It is bounded with the Sea on all sides, save only where it is is conterminat with *Asia*. 3. The principall regions of it, are, *Mauritania*,
M Numidia;

Numidia, Libya, Cyrenaica, Egypt, and Æthiopia. 4. The most famous kingdoms are these, Morocco, Fez, Algier, and also that of Prester John, or Æthiopia. 5. The greatest Mountains are, Atlas, and that other whence Nilus springeth. 6. The principall rivers of Nigars, and Nilus, which is accounted to bee the greatest in the world, and as Diodorus Siculus affirmeth, encompasseth 700. Islands. 7. The principall Merchandise of Africke, is Ivory, Civet, Gold, Cotton Wooll, Jewels, and certain kinds of spices, as also Salt, Lions, Camels, &c.

Asia (so called from Asia, the mother of Prometheus, as the common received opinion is; or else from a certain Heroe of that name as Hippias in Eustathius will have it, at this day wholly in subjection to the great Turke, and the Persian, as far as to the East Indies, the greatest part whereof is under the Kings of China & Pegu. But the more Northern parts of Asia are possessed by the Muscovites, Tartarians, and those that inhabit the region of Cathaia. The principall Islands appertaining unto it, are Cyprus, and Rhodes in the Mediterranean: and on the South side, Sumatra, Zeilam, Java, Major and Minor, the Moluccan and Philippine Islands, beside Borneo, and almost an infinite company of others. And on the East of it there lye the Japonian Islands.

PONT. That is ought to be written Sinæ, not Chinæ, as our Author in this place, and commonly all other writers use to doe, appeareth manifestly out of Ptolomy, who alwayes calleth them

them Sinæ. The eighth Table also of Asia in Ptolomyes Geography, placeth the Scythians called Cathæ, (which our Author calleth the region of Cathaia.) betwixt the mountaines Imavus and Emodus: and the region of the Sinæans a part of it beyond the same Emodus and Octoro cara, which are hills in the Country of the Seres, and looking towards the South East. So that I cannot but wonder that Matthæus Riccius a Jesuite, in his Sinæan expedition should take so much pains to prove, that the Kingdom of Cathaia and of the Sinæans is all one. But it were easie, by other, and those more proper arguments and testimonies, (were this place convenient) to prove the contrary to this his assertion.

Now as concerning Asia, these things occurre in it worth our observation. 1. That it is twofold, Asia Minor, and Major. 2. Asia Minor, or the lesser Asia, is bounded on the East by the Euxine Sea; on the South by the river Euphrates; on the West by the Mediterranean, on the North by the Aegæan Sea. 3. The principall countries it contained anciently, were these: Cilicia, Pamphilia, Caria, Lycia, Jonia, Lydia, Æolia, Mysia, Bithinia, Paphlagonia, Cappadocia, Galatia, Lycaonia, and Pisidia. 4. To the greater Asia these Regions appertained: Syria, Armenia, Chaldæa, Arabia, Persia, Tartaria, Hircania, Parthia, and India. 5. In both of them there are settled at this day these Empires; nameily, the Turkish, Persian, Tartarian, Indian, and Sinenian or Chinean. 6. The chiefe hills of note in it, are Taurus, Caucasus, and Imavus. 7. The

principall Rivers, Euphrates Ganges, and Indus, 8. The chiefeft traffick is, Gold, Pearle, Jewels, all kind of Spices, Muske, Frankincense, Balsame, Amber, Silks, Ivory, and Elephants.

America, (so called from *Americus Vesputius*, who first discovering it, gave it both name and boundz,) is terminated on the East side, (on which it lokes toward *Europe*, and *Africa*) by the *Atlantick Ocean*: on the West with the Sea, which they call, *del Zur*, or the South Sea: on the South it is bounded with the Straits of *Magellans*. But as for the Northern parts of it, they are not yet thoroughly discovered, or the Limets thereof knowne: notwithstanding the many adventures by Sea of our Countrymen, *M. Martin Frobisher*, and *M. John Davis*, having given strong arguments of hope, that it is on that side bounded by the frozen Sea. It containeth in it these principall regions. First, on the North, that Countrey which the Spaniards call, *Tierra de Labrador*: after which followeth that which they call, *Baccalearum Regio*: then *Nova Francia*: after this *Virginia*: then *Florida*: next to this *Nova Hispania*, famous especially for the City *Mexico*, and last of all the Kingdomes of *Brasil* and *Peru*, which are the most Southern parts of all. There are also many adjacent Islands: most of which lye in the Bay of *Mexico*, Eastward from *America*: the most notable of which are *Cuba* and *Hispaniola*, besides many other of lesse note.

There

There are also many other parts of the world, not yet throughly known or discovered, as namely those southern coasts, wherein stands *Nova Guinea* lying beyond the Indian Sea, which whether it be an Island, or else a part of the maine Continent, is not yet discovered: and likewise, that the other tract of the Southern known Continent, which is called *Magellanica*: as also these Northern parts of *Europe, Asia, & America*, which have been but lately detected by many of our English Navigators, but not as yet tully searched into.

C H A P II.

Of the Circumference of the Earth, or of a Greater Circle; and of the Measure of a Degree.

TH remaineth now that wee speak somewhat of the circumference of the Earth, or of the greatest circle in it; the knowledg whereof is very necessary, both for the study of *Geography*, as also for the easier attaining to the Art of Navigation. And therefore, I hope, I shall not seeme impertinent, if I insist something the longer on this argument: especially seeing that there is great diversity of opinion among the most learned Authors that are extant, concerning this matter; in somuch that it is not yet determined, which of them we are to follow.

Aristotle in the end of his 2^d Book *de Cælo*, affirm's (and that according to the doctrine of the Mathematicians, as himself saith) that the circumference of the Earth is 400000. furlongs *Cleomedes lib. 1.* reckons it to be 300000. for he saith that the Verticall Points of *Lysimachia* and *Syene*, were observed by Sciotericall Instruments, to be distant from each other the 15th. part of the same *Meridian*. Now the distance between these two places he sets down to be 20050. furlongs: So that if 20000. be multiplied by 15, the whole will arise to 300000. *Eratosthenes* (if we may believe *Strabo*, *Vitruvius*, *Pliny*, and *Censorinus*) would have the whole compasse of the Earth to containe 252000. furlongs. To which number *Hipparchus*, as *Pliny* testifieth, added very near 25000. more. Yet *Strabo* as well in the end of his 2^d book of his Geography, as else where, affirmeth, that hee used the same measure that *Eratosthenes* did: where he saith, that according to the opinion of *Hipparchus*, the whole quantity of the Earth containeth 252000. furlongs: which was the measure delivered also by *Eratosthenes*. Which opinion of *Eratosthenes* is seconded also by that fabulous relation of *Dionysiodorus*, recorded by *Pliny. lib. 2. cap. ult.* Where he saith, that there was found, in the Sepulcher of *Dionysiodorus*, an Epistle written to the gods; wherein was testified, that the Semediameter of the Earth contained 4200. furlongs. Which number being multiplied by 6. the Product will bee 252000.

Cleo-

Cleom:des relating the observations of *Eratoſthenes*, and *Poſidonius*, making it to be ſome-
what leſſe, and that according to the doctrine
of *Eratoſthenes*: to wit, 250000. furlongs.
For he placeth *Syene* and *Alexandria* under the
ſame *Meridian*, Now *Syene* being ſituate dire-
ctly under the Tropick of *Cancer*, the Sun being
then in the Summer Solſtice the *Gnomons* caſt
no ſhadow at all. For confirmation of which,
the experiment was made, by digging a deepe
Well, which, at that time of the yeare, was
wholly enlightened on every part: as it is re-
ported both by *Pliny* and alſo by *Strabo* before
him. But at *Alexandria*, when the Sun is in
the Summer Tropick, the *Gnomon* is obſerved
to caſt a ſhadow to the fiftieth part of the cir-
cumference, on which it is erected to right an-
gles, ſo that the top of the ſame, is the center of
the circumference. Now the diſtance betwixt
Syene and *Alexandria* is commonly ſet down
by *Eratoſthenes*, *Pliny*, and *Strabo*, to be 5000.
furlongs. If therefore 5000. be multiplied by
50. the whole will ariſe to 250000. which is
the number of furlongs aliigned to the cir-
cumference of the whole earth by *Eratoſthenes*
Poſidonius, proceeding after another method,
though not unlike this, labours to prove the
whole circuit of the Earth to contain 240000.
furlongs. And firſt hee taketh for granted
(which is alſo acknowledged by *Ptolomy*, lib. 5.
c p. 3. *Almageſt*.) that *Rhodes* and *Alexan-
dria* are ſituate under the ſame *Meridian*. Now
that bright Star in the ſterne of *Argo*, (which

they call *Canobus*, and which never appeareth in Greece, which seemes to be the reason why *Aratus* maketh no mention of it: first beginneth to appeare above the Horizon at *Rhodes*: but it doth but *stringere Horizontem*, just touch the Horizon, and so, upon the least circumvolution of the heavens, setting againe, or else, as *Proclus* saith, is very hardly seen, unlesse it be from some eminent place. But when you are at *Alexandria*, you may see it very cleare above the Horizon. For when it is in the *Meridian*, that is, at the highest elevation above the Horizon: it is elevated above the Horizon about the fourth part of a Signe: that is to say, the fourteenth part of the *Meridian* that passeth through *Rhodes* and *Alexandria*. The same is affirmed also by *Proclus*. if you read him thus: *Canobus in Alexandria conspicuè cerni, quarta circiter Signi portione supra Horizontem extante*: as it ought to be; and not as it is corruptly read, *in Alexandria prorsus non cerni*. It is not seen at all: in stead of it, is seen very plainly: *αφ' ους* being crept into the text, perhaps in stead of *επαυς*. Now the distance betwixt *Rhodes* and *Alexandria* is set down both by him and *Pliny*, to bee 5000. furlongs: which being multiplyed by forty eight, the product will be 240000. the number of furlongs, agreeing to the measure of the Earths circumference, according to the opinion of *Posidonius*.

Ptolomy, every where in his *Geography*, as also *Marinus Tyrinus* before him, have allowed
but

but 500. furlongs, to a degree in the greatest circle on the earth, of which the whole circumference containeth 360. so that the whole compass of the Earth, after this account, containeth 180000. furlongs. And yet *Strabo* affirms in his lib. 2. *Geograph.* that this measure of the Earths circumference set down by *Ptolomy*, was both received by the Ancients, and also approved by *Pofidonius* himself.

So great is the difference of opinions, concerning the compasse of the Earth: and yet is every one of these opinions grounded on the authority of great men. In this so great diversity therefore, it is doubtfull whom we should follow. And if you should desire to know the cause of all these dissentions; even that also is altogether as uncertain. *Nonius*, and *Peuce-rius* would perswade us, that certainly the furlongs they used were not of the same quantity. *Manrolycus*, and *Philander* conceive the difference of furlongs to rise out of the diverse measure of Pases. And therefore *Manrolycus* takes great paines to reconcile them; but in vaine; for they seem not capable of any reconciliation. They tell us of divers kinds of Pases in use among the Ancients. It is true: we assent to them herein: but withall desire to heare of some diversity of furlongs also, or at least, of feet. The Greekes (as I conceive) measured not their furlongs by Pases; but by feet, or rather *ταῖς ὀργμαῖς*. Now *ὀργμὰ* is the measure of the extension of both the hands, together with the breast betwixt, containing
fixe

sixe feet, which wee commonly call a fadome, and is a measure in familiar use with our Mariners, in sounding the depth of the Sea, or other waters. This word notwithstanding is translated by many, a Pase : but how rightly, I leave it to learned men to judge. *Xylander* in his translation of *Strabo*, alwayes rendereth it, an Ell. In like manner a furlong is defined by *Herodotus*, a very ancient Greek Author, to consist of 600. feet : the same also is affirmed by *Suidas*, by much later then hee. Yet *Herae Mechanicus* (or at least his Scholiast) one, as I conceive, of the lowest rank of Ancient Writers.) will have a furlong to contain 100. fadomes ; a fadam foure Cubits : a Cubit a foot and a halfe, or twenty four digits : But you will say perhaps, that *Censorinus* proposeth three severall kinds of furlongs : the first of which is the *Italian*, consisting of 625. feet : which he would have us understand to be that which is commonly used in measuring the Earth. The second is the *Olympian* : containing 600. feet : and the third and last is the *Pythean*, consisting of 1000. feet. But to let passe this later, if wee doe but looke more nearly into the matter, we shall find the *Italian* and *Olympian* furlongs, howsoever they differ in names, yet to be no other but the self samething. For the *Italian* furlong, which containeth 625. Romane feet, (according as *Pliny* testifieth, in his second book and twenty third Chapter) will be found to be equall to the *Olympian*, consisting of 600. Grecian feet

feete. For 600. Grecian feet, are equall to 625
Romane: for as much as the Grecians foot ex-
ceeds the Romane by a twenty fourth part: as
much as in the difference betwixt 600. and
625.

Amongst these so great diversities of opini-
ons, let us give our conjecture also, both what
may be the cause of so great disagreement, and
also which of them we may most safely follow.
We will therefore passe by *Aristotle*, whose as-
sertion is onely defended by a great name. And
for *Gleomedes* his opinion, of the Earths being
in compasse 200000. furlongs, we should scarce
vouchsafe to mention it, but that *Archimedes*
also had taken notice of the same, as of a por-
tion not altogether disallowed in his time. Let
us therefore examine *Eratoſthenes*, and *Posido-
nius*, whose opinions seem to be grounded on
more certain foundations. The cause there-
fore of their disagreement I conceive to bee
in that neither of them had measured exactly
the distance of those places which they layd
down to work on, but took them upon
trust, from the common reducing received of
Travailleurs: save only, that of the two, *Posido-
nius* is the more extravagant. Whereas on the
contrary *Ptolomy* grounded his opinion on the
distances of places exactly measured, as him-
self affirmeth; when he saith: That the la-
titude of the known parts of the world is
79. degrees, and 45. minutes. Or supposing
it to be full 80. degrees; it will then contain
40000. furlongs, allowing for every degree
five

five hundred furlongs: as by measuring the distance of places exactly, we have found it to be

But *Eratosthenes* is much taxed by *Hipparchus*, for his strange mistakes and grosse ignorance in setting down the distance of places: as *Strabo* testifieth in his first book. For he reckons betwixt *Alexandria* and *Carthage* above 13000. furlongs, whereas (saith *Strabo*) it is not above 9000. So likewise *Posidonius* is to be blamed, for setting down the distance betwixt *Rhodes* and *Alexandria* to be 5000. furlongs, and that from the relation of Mariners, whereas some of them would have it to be but 4000. and others 5000. as *Eratosthenes* confelleth in *Strabo*: but addeth moreover, that he himself had found by Sidericall instrument, that it was but 3750. And *Strabo* would have it to be something lesse then that, namely 3640. furlongs. So that hence, we may safely conclude, that *Ptolomies* opinion, being grounded upon the more exact and accurate dimensions of distances, (as himself professeth) must necessarily come nearer the truth then the rest.

But *Franciscus Maurolycus*, Abbot of *Messava*, whiles hee goes about to defend *Posidonius* against *Ptolomy*, is overtaken himself in an errour, before hee is aware. For he suspecteth the truth of *Ptolomies* assignement of the latitude of *Rhodes*, which he sets down to be thirty six degrees. And hee adverti-
seth

sethus, that certainly the number in his Geographicall tables are corrupted: which, we confesse, is most certain. But in the meane time let us see how he proves them to be so, in this Latitude of *Rhodes*. *Posidonius* (saith he) out of his owne observations, setteth down the Latitude of it to be thirty eight degrees, and an halfe: unlesse that *Ptolomy* bee out also in designing the Latitude of *Alexandria*; which *Manrolycus* thinkes cannot possibly be. But wee affirm on the contrary side, that *Ptolomy* himself is against this Latitude, not onely in his Geographicall booke, but also in diverse places throughout the *Almagest* also, and especially in the *lib. 2. cap. 6.* where he sets down the same latitude for *Rhodes*, that he hath in this Geography: adding moreover the quantity of the longest day, and also what manner of shadowes the *Gnomonos* cast, both when the Sun is in the *Æquinoctiall*, as also in the Tropicks: all which do plainly prove the same He also very often hath the same latitude of it in his Planisphære: unlesse you will say, that either *Masses* the Arabian, in translating it into Arabick, or else *Rodulphus Brunensis*, who translated the same again out of Arabick into Latine, have deceived us. Hitherto therefore we stand on equal tearmes. But he proceeds, and saith, that this opinion of *Posidonius* is favoured also by *Proclus*, & the observations of *Eudoxus Cnidius*, delivered by *Strabo*. Let us therefore see what all this is. *Posidonius* (saith *Strabo*) reports, that himself being
some

sometimes in a City distant from the *Gaditan* Straits 400. furlongs, saw from the top of an high house a certain Starr, which hee took to bee *Canobus*: and those that went thence more Southward from *Spaine*, confesse that they saw it also plainly. Now the Tower *Cnidus*, out of which *Eudoxus* is said to have seen *Canobus*, is not much higher then the other buildings. But *Cnidus* is in the same Climat with *Rhodes*, as is also the *Gades*, with the Sea coasts adjoyning. Thus *Strabo*. But what doth he conclude hence against *Ptolomy*? That *Canobus* may be seen in *Cnidus*? Wee deny it not. Or that *Cnidus* is in the *Rhodian* Climate? *Ptolomy* acknowledgeth as much: for hee makes it to have not above 36. gr. 15. m. of Latitude, in the fifth book of his *Geography*. But is not *Ptolomy* out also in assigning the Latitude of *Cnidus*? That the Latitude of *Rhodes* is no greater then *Ptolomy* hath set it, may be proved even out of *Proclus* himself: for he makes the longest day at *Rhodes* to be 14. hours and an haife. And *Ptolomy* will have the same to bee equall both at *Rhodes*, and *Cnidus*. And to this assenteth *Strabo* likewise, save onely that in one place he sets it down to be but 14. hours bare: so that by this reckoning it should have lesse Latitude. Now *Proclus* his words are these, In the Horizon of *Rhodes* (saith he) the Summer tropique is divided by the Horizon in such sort, as that if the whole circle bee divided into forty eight parts, twenty nine of the same

samedo appeare above the Horizon, and 19. lye hid under the Earth Out of which division it follows, that the longest day at *Rhodes* must be 14. Æquinoctiall hours and an halfe, and the shortest night, 9. and an halfe, Thus he, I do not deny, but that *Posidonius* his setting down of the quantity of the portion of the Meridian intercepted betwixt the verticall point of *Rhodes* and *Alexandria*, might deceive *Pliny*, *Proclus*, and others. Yet *Alfraganus* draweth his second Climate through *Cyprus* and *Rhodes*, and makeih it to have the longest day of 14. hours and an halfe, and in latitude 36. gr. two thirds. So that there is but very small difference betwixt him and *Ptolomy*. And even *Manrolencus* himself. when in his Cosmographical Dialogues he numbereth up the Parallels, he maketh that which passeth through *Rhodes* to have 36. gr. and a twelfth of Latitude: herein differing, something with the most, from *Posidonius*. *Eratosthenes* his observations also do very much contradict *Posidonius*. For *Eratosthenes* saith, that he found by Scioterlicall Gnomons, that the distance betwixt *Rhodes* and *Alexandria* was 3750. furlongs. But let us examine this a little better. The difference of Latitude betwixt these two places he found Scioterlically, after his manner, to be something more than 5. degrees. And to this difference, (according to his assumed measure of the compasse of the Earth, wherein he allows 700. furlongs to a degree) hee attributes 3650. furlongs. Neither is there any other

other way of working by Scioterickall instruments (that I know) in finding out the distance of furlongs betwixt two places; unlesse we first know the number of furlongs agreeing either to the whole circumference of the Earth, or else to the part of it assigned. Let us now see if we can prove, out of the observations of *Eratosthenes* himself, that neither *Possidonius* his opinion concerning the measure of the Earths circumference, much lesse *Eratosthenes* his owne can be defended. And here we shall not examine his observation of the difference of Latitude betwixt *Alexandria* and *Syene*, that so we might prove out of his own assumptions, that the whole compasse of the Earth cannot be above 241620. furlongs: as it is demonstrated by *Petrus Nonius*, in his lib. 2. cap. 18. *De Navigatione*. Neither doe we enquire, how truly hee hath set down the distance of these two places to bee 5000. furlongs: whereas *Solinus* reckoneth not from the very Ocean to *Meroë* above 620. miles, which are but 4960. furlongs. Now *Meroë* is a great deal farther then *Syene*. Neither will wee question him at all, concerning the small difference that is betwixt him and *Pliny*, who reckons from the Island *Elephantina* (which is 3. miles below the last Cataract, and 16. miles above *Syene*) to *Alexandria* but 486. miles so that by this reckoning, betwixt *Syene* and *Alexandria*, there will not be above 4560. furlongs. But we will proceed a contrary way to prove our assertion. This one thing therefore

Wee

we require to be granted us ; Which is : that
 looke how great a space the Suns Diameter
 taketh up in his Orb; for the like space on the *Ter-
 restriall Globe* shall the *Gnomons* be without any
 shadow at all, while the Sun is in their Zenith.
 Which if it be granted, (as it is freely confessed
 by *Pofidonius* in *Cleomedes*,) we have then got-
 ten the victory.

Now it is affirmed by *Eratosthenes*, that the
 Sunne being in the begining of Cancer, and
 so directly in the Verticall point at *Syene*;
 both there, and for 300. furlongs round a-
 bout, the *Gnomons* cast no shadow at all. Let us
 now therefore see, how great a part of this Orb
 the Sunns Diameter doth subtend. For by
 this meanes, if this position of *Eratosthenes*;
 which wee have now set down, bee true,
 we may easily finde out, by it, the whole cir-
 cuit of the Earth. *Firmicus Maternus* makes
 the Diameter both of the Sun and Moon to
 be, no lesse then a whole degree. But he is too
 farr from the truth : and assigneth a greater
 quantity, either then he ought, or we desire.
 The Egyptians found by Hydroscopicall
 instruments, that the Diameter of the Sunne
 takes up the Seven hundred and fifty parts of
 his Orbs. So that if 300. furlongs on Earth
 answer to the seven hundred and fiftieth part
 of the whole circumference of the same : the
 whole circuit of it then will bee but 225000
 furlongs. The fabricke and use of this in-
 strument is set down by *Proclus* in his *cup* 3.
Designation. Astronomi. And *Theon* also speaketh
 N much

much of it in his Commentaries upon the 5. lib. *Aimagest*. *Ptolemy*. as also doth *Manrolicus* in his third *Dialog. Cosmograph.* But these kinds of observations are not approved of by *Ptolemy* And *Tibon* also, and *Proclus* demonstrate them to be obnoxious to much error. And therefore we examine the matter yet a little further.

Aristarchus Samius, (as he is cited by *Archimedes*) affirmed that the Suns apparent Diameter taketh up the seven hundred and fiftieth part of the Zodiack, that is to say, 30. minutes; and is equal to the apparent Diameter of the Moon: as he hath it (as I remember) in the 7. and 8. Propositions of his book *De magnitud. & distant. Solis & Luna.* The same was the opinion also of *Archimedes* himself. But, in the meane time, I cannot free my selfe of a certain scruple cast in my way, by another supposition of the same *Aristarchus*, in the very same book, where he would have the Diameter of the Moon to bee 2. degrees. *Archimedes* also, out of his owne observations, by Dioptrickall instruments, hath defined the Suns Diameter to bee greater then the 200th part of a right angle, that is to say, 27. minutes: yet lesse then the 164th part of a right angle, which is 33. minutes. But he himselfe confesseth, that there is not so great credit to bee given to such like observations, as are made by these Dioptrickall instruments, as by them to bee able exactly to find out the Diameter of the Sun or Moon: seeing that neither the light, nor the hand, nor yet

yet the instruments themselves, by which the observations are to be made, can be every way so exact and sure, as not to faile. *Ptolomy* by the same Dioptrickall instruments, as also by the manner of Eclipses, found the Diameter of the Sun to contain 30. m. 20. sec. and to bee equall to the apparant Diameter of the Moon, when shee is at the greatest distance from the earth, which is, at the full Moon, and in Conjunction with the Sunn. Now whereas he would have this magnitude to bee constantly the same, and invariable: *Proclus* approves not of him herein, as appears in his 3. cap. *Designation. Astronom.* being hereto induced by the Authority of *Sosigenes* a Peripateticke: who in those bookes of his, which he intituleth, *De revolutionibus*, hath observed, that in the Eclipses of the Sun, there is sometimes a certain little ring or circle of the Sun to be perceived enlightened, and appearing plainly on all sides round about the body of the Moon. Which if it be true, it is impossible then, that the apparent magnitude of the Sunn shall bee, at all times, equall to that of the Moon in their Conjunctions and oppositions. And this is the cause perhaps, that those that have come after *Ptolomy*, have endeavoured to examine these things more accurately. And first of all *Albateni* found the Diameter of the Sun, when he was in the *Apogaeum* of his Eccentricke, to be 31. m. 20. sec. which is the same which *Ptolomies* observation: but in the *Perigaeum*, to be 33. m. 40. sec. But Co-

fernius went yet further, and found the Diameter of the Sun, when he was in his greatest distance from the Earth, to be 31. m. 48. sec. and when he is nearest of all, to be 33. m. 54. sec. Now therefore If wee work upon this ground here laid before us, and take the Diameter to be 32. m. it will then follow, that if 300 furlongs answered to 32. minutes, the whole circuite of the Earth will be but 202500. furlong. : which falls short of that measure which *Posidonius* hath set down, but much more of that which *Eratosthenes* hath delivered. And thus much have wee thought good to say (with all due reverence to the judgements of learned Authors) in examination of those things, which have been delivered by the Greeks, concerning the measure of the Earths circumference.

The way of measuring, used here with us, is by Miles, and Latitudes: of the former whereof 60. and of the later 20. answering to a degree. So that the circumference of the Earth, containeth 21600. English Miles: which also agrees exactly with that of *Ptolemy*. For wee find our English foot to be just equall with the *Grecian*, by comparing it with the *Grecian* foot. which *Agricola*, and others have delivered unto us, out of their monuments of antiquity. Now one of our Miles containeth 5000. feet of our English measure: and a furlong 600. *Grecian* feet. Now if you multiply the measure of a furlong by 500. (for so many furlongs doth *Ptolemy* allow to a degree) and so

so likewise the measure of a Mile, which is 5000. feet, by 60. (which is also the number of miles that were reckon for a degree,) they will both produce the same number of feet, viz. 300000. So that from these grounds we may certainly conclude, that the common computation received among our Mariners, doth agree most exactly with that of *Ptolomy*.

The *Italians* also make 60. miles to bee the measure of a degree: but their measure is something less then *Ptolomies*. The *Grecians* reckon 15. miles to a degree: one of their miles containing 4. *Italian*: so that this reckoning of theirs falls just as much short of *Ptolomyes*, as the *Italian* doth. For according to their computation, a degree containeth not above 480. furlongs, every *Italian* Miles consisting but of 8. furlongs: (unless perhaps you rather approve of *Pelibi* his opinion, who,) as he is cited by *Strabo* (over and above 8. furlongs, will have 2. *Plethra*, which is the third part of a furlong, to be added to every mile: which is the just measure of our English mile.) Yet *Appian* saith that 15. *Germane* miles, are as much, as 60. *Italian*: and 60. *Italian* miles contain 480. furlongs: which is lesse then *Ptolomies* measure by 20. furlongs, which make up two *Italian* miles, and an halfe.

The *Spaniards* reckon to a degree, some of them 16. leagues and two third parts: and some seventeen and an halfe. But how their measure stands, compared with the *Grecian* furlongs, or with the English, Italian, or Ger-

mane miles, I have not yet certainly learned, Yet *Nonius* seemeth to equall the Spanish league with the *Schoenus*, or *Parasanga*: which if it be so, then those that allow 16. leagues and 2. thirds to a degree, have the same measure that *Ptolomy* hath deliuered: but those that allow 17. and an half, make it somewhat too large.

It only now remaineth to see, what is the doctrine of the *Arabians* concerning this matter. Of which the most ancient have assigned to the whole circumference of the Earth, 2400. Miles, or 3000. *Parasange*: so that after this computation, a Degree must contain 66. Miles, with two third parts. And this measure is used by *Alhazenus*, in the end of his book, *De Crepusculis*. *Alfraganus*, and some of the later Arabick writers, since *Almamons* time, do generally account 20400. Miles to be the just measure of the *Terrestriall Globe*: So that one degree containeth, by this reckoning, 56. Miles and a third part. And it is reported by *Abulfeda*, in the beginning of his Geography, how that, by the command of *Almanon*, King of the *Arabians*. or Caliph of *Babylon*: there were certain men employed, who should observe in the plaine field of *Singar* and the adjoyning Sea coasts, (meaning the places in a direct line toward the Pole, (how many Miles answered to a degree: and that they found, by just computation, that in going the space of one degree, there were spent full 56. Miles without any fractions, and sometime 56. Miles, and a third part which make up

1333. cubits, with two Thirds. But now what proportion the *Arabian* Mile beareth to ours, or the *Italian*, or *Germane* Mile, is not so easie to determine. Yet I conjecture it cannot be lesse than ten Furlongs. The *Parasanga* (as *Jacobus Christmannus* tells us, out of *Abulfeda*, that great *Arabian* Geographer) containeth three *Arabian* Miles, according to the doctrine both of the *Ancient*, and *Moderne* Writers among them. Now a *Parasanga* (as it appeares plainly out of *Herodotus*, *Xenophon*, and others) containeth thirty furlongs: so that, by this account, every mile must comprehend ten furlongs. And for confirmation of this, we may observe, that, among the *Greekes*, there were two kinds of Cubits in use; the one, the common or ordinary Cubit, which contained two foot and an halfe of *Grecian* measure, or twenty foure digits, of which sixteen went to a foot. The other was the *Kings* Cubit, in use among the *Persians*: which was greater than the common Cubit by three fingers breadth. Now *Alfraganus* affirmeth that the *Arabian* mile contained 4000. Cubits, according to the ordinary measure. So that if this Cubit be equall to the *Grecian* Cubit, one of their miles will then contain 6000. *Grecian* feet, which makes up ten furlongs. Now whereas the *Parasanga* is reckoned by some to contain 40. furlongs, and by others 60. yet no body alloweth to it lesse then 30. with which later account if wee should; with *Herodotus*, *Xenophon*, and others, rest our selves con-

tented (neither indeed is it our Intention to stand long in disputing, whether or no in diverse places, the measure of the *Parasanga* were also different, as *Strabo* seemes to think, who observed the very same difference in the Egyptians *Sebœnus*, when as being conveyed on the River *Nilus* from one City to another, he observed that the Egyptians in diverse places, used diverse measures of their *Sebœnus*;) I say, if we should rest upon their determination, who assigne but 30. furlongs to a *Parasanga*; then one of the *Arabian* miles will containe tenn furlongs at the least. Which conjectures, if they be true, we cannot then assent to those learned men, *P. Nonius*, and *Jacobus Christmannus*, who will have the *Arabian* Mile to be all one with the *Italian*,

In this so great diversity of opinions, concerning the true measure of the Earths circumference, let it be free for every man to follow whomsoever he please. Yet were it not that the later *Arabians* do countermand us, by proposing to us their Positions, which they averre to have been grounded upon most certain and exact mensurations of the distances of places; we should not doubt to preferre *Ptolomies* opinion, I will here propose unto your view a list of all those opinions, which carry in them any shew of probability.

Authors

{AUTHORS} {FURLONGS}

The circuit of the whole earth containeth ac- cording to	Strabo, and	{	252000.
	Hipperchus,	{	250000.
	Eratoſthenes	{	240000.
	Posidonius & the Ancient	{	180000.
	Arabians,	{	204000
	Ptolomy and our Engliſh-	{	172800.
	men.	{	
	The modern	{	
	Arabians,	{	
	The Ita-	{	
	lians and	{	
	Germans.	{	

{AUTHORS} {FURLONGS.}

The measure of a Degree ac- cording to	Strabo, and	{	700.
	Hipparchus	{	694;
	Eratoſthenes	{	666;
	Posidonius & the Ancient	{	500
	Arabians,	{	566;
	Ptolomy and our Engliſh	{	480.
	men.	{	
	The later	{	
	Arabians,	{	
	Italians and	{	
	Germanes.	{	

MILES.

A Treatise of the CHAP. II.
 {MILES.} {FURLONGS.}

The	Italian	} containeth	8.
	English		8 $\frac{1}{2}$
	Arabian		10
	Germane		32

PONT. For the finding out of the circumference or circuit of the Terrestrial Globe, these Hypotheses are first to be laid down for a ground: 1. That the greatest circle in the Earth, as well as in the Heavens, is to be divided into 360. parts, or degrees, 2. That one of these degrees doth contain 500. furlongs, or 62500. Romane pases, and 60. English miles. 3. That 8. furlong, and a third part make an English Mile.

These things being presupposed, we must multiply 360. degrees by 60. miles, which done, the product will be 21600. English miles. Or if you multiply 360. degrees, by 500. furlongs; the whole will be 180000. furlongs, which is the measure of the circumference of the Earth.

So likewise if 360. be multiplied by 15. the whole will be 5400. Germane miles: and if the number of the degrees be multiplied by 25. there will arise 9000. French miles. All which may be thus expressed.

A degree containeth.	15. Germane	} Miles, each of w ^{ch} containe severally.	4000.	} Pases.
	60. Italian		1000.	
	60. English		1000.	
	25. French		2400	
	17 $\frac{1}{2}$. Spanish			

In like manner the Circumference of the Earth may as easily bee found out by any of the fixed
 Sta's

Celestiall and Terrestriall Globe.

16

Stars, as the Virgins Spike, or the like. For if we take any two places which are situated under the same Meridian, and the distances in a right line exactly known, so that in both places the Meridian Altitude of the same Star be certainly known also: the difference of it's Altitude will be the number of degrees of distance betwixt the same places, Wherefore seeing it is certainly known, as we have already said, how many miles answer to a degree, it is very easie then to gather how many miles the circumference of the whole Earth is also. As for example: Suppose London and Edenburg in Scotland to be under the same Meridian, and the Elevation of the Pole at London to be 52. degrees, and at Edinburgh 56. gr. 20. m. Now if you substract the lesser number, which is 52. from the greater, 56. gr. 20. m. the difference wil be, 4. gr. 20. m. which being resolved into minutes, it will be found to be the 260. distance of miles betwixt London and Edinburgh. Therefore we must now say, that as 4. gr. 20. m. is to 260. miles: so is 360. degrees to 21600. English miles.

The



The fourth Part,

CHAP. I.

Of the Use of Globes.



hitherto wee have spoken of the *Globe* it self, together with it's dimensions, circles, and other instruments necessarily belonging there to. It remaineth now that we come to the practise of it, and declare it's several uses And first of all, it is very necessary for the practise both of Astronomy, Geography, and also the Art of Navigation: For by it there is an easie and ready way layd down, for the finding out both of the place of the Sun, the Longitudes, Latitudes, and Positions of places, the length of daies and houres; as also for the finding of the Longest Latitude, Declination, Ascension both Right and Oblique, the Amplitude of the rising and setting of the Sunne and Starrs, together with almost an infinite number of the like things. Of the chiefe of all which wee indeed here briefly to discourse, omitting the enumeration of them all, as being tedious and not sutable to the brevity we intend Now that all these things may be performed farr more accurately, by the help of numbers,

numbers, and the doctrines of Triangles, Plains, and Sphæricall bodies, is a thing very well known to those that are acquainted with the Mathematicks, But this way of proceeding, besides that it is very tedious and prolix, so likewise doth it require great practise in the Mathematicks. But the same things may be found out readily and easily, by the help of the *Globe*, with little or no knowledg of the Mathematicks at all.

PONT. For the better understanding of those things which shall bee spoken hereafter, there are two things especially to be promised: the first whereof is, concerning the position of the *Globe*, and the other *Climates*. Now touching the position of the *Globe*, you are, first of all, to take care that it bee placed perpendicularly to the true *Horizon*: 2. That the distinction of the winds answer directly to the winds of the reall *Horizon*, that so the East on your materiall *Globe*, may look directly toward the true East of the *World*. For which purpose especially there is usually placed a Nauticall *Compass* in the bottome of the frame. When you have thus placed your *Globe*, so that it may be turned about any way at pleasure, yet so that the base or foot bee not moved out of its place, the next thing that is to bee enquired after, is the *Latitude* of the place wherein you live: which according as it is greater, or lesser, you must elevate the *Pole* of your *Globe* above the *Horizon* proportionally. As for example, if the *Latitude* be 50. 51. or 52. grad. or lesse Northward, then must you elevate the *Arctick Pole* just so many degrees

degrees above the Horizon. And so likewise if the latitude be Southern, you must doe the like by the Antartick or South Pole. But under the *Æquator*, where there is no latitude at all, both the Poles must bee placed in the very Horizon, at opposite points.

2. A Climate is a space of the habitable parts of the Earth, comprehended betwixt two circles Parallel to the *Æquator*, in which space there is halfe an hours difference in the longest day. Now those that inhabit under the *Æquator* have a perpetuall *Æquinoxe*, for the day with them is alwaies twelve hours longer, and the night as much. But as their situation is removed from the *Æquinoctiall* nearer to either Pole, the further they are from the *Æquinoctiall*, the greater is the inequality of the Artificiall day and night: out of which variation of Artificiall daies, the diversity of Climates also is taken and distinguished. For wheresoever this difference amounteth to halfe an houre, there presently begins another Climate. Now the ancient Geographers constituted in every Climate, three Parallels, of which the two outwardmost, namely the first and the third, do comprehend and terminate every Climate: and the second divideth it in the midst. So that the proportion betwixt the Climate and the Parallels was Duple; for the Climes, as we have said, were distant from each other halfe an houres space in the length of the day, but the Parallels were distinguished by quarters of an houre.

Now as concerning the number of Climates,
The

The Ancients, at first, reckoned but seven, but Pto-
lomy in his Tables of Ascensions, in the 2. lib. May.
Constiution, acknowledge nine: all of which de-
rived their names from some eminent place, either
hill or river, situate in the midst of the said Cli-
mate. The first Clime toward the Arctick Pole, be-
ginning from the Equator, they called Diameroës,
because the midst of this Clime runneth through Me-
roë, which is an Island in Africke encompassed a-
bout with the river Nilus, where the longest day is
thirteen hours; in the beginning therefore of this
Clime it must be 12^h hours long. On the opposite
part of the Equator, the first Southern Climate may
in like manner be called, Antidiameroës. But these
other Climes were not constituted neither by Pto-
lomy, nor any of the ancient Geographers. Yet by the
like reason that part of the world also may as well
be described into Climate, reserving the same names
that the Northern Climes are known by, and onely
adding to them the preposition αντι which signi-
fies as much as, Opposite, or over against. And then
the Scheme, of them all will be thus,

Northern Climates.

Southern Climates.

- | | |
|-------------------|-----------------------|
| 1. Diameroës. | 1. Antidiameroës. |
| 2. Diasyenes. | 2. Antidiasyenes. |
| 3. Dialexandrias. | 3. Antidialexandrias. |
| 4. Diarhodu. | 4. Antidiarhodu. |
| 5. Diarhomet. | 5. Anididiarhomet. |
| 6. Diapontu. | 6. Antidiapontu. |
| 7. Diaborithenes. | 7. Antidiaborithenes. |
| 8. Diabritanias. | 8. Antidiabritanias. |
| 9. Diatanaidos. | 9. Antidiatanaidos. |

Tot

Yet some there are that do not approve of this distinction of Climates, among whom is John Gas. in his lib. 24. System. Geograph. cap. 2. probl. 12. And the reasons they alledg are these.

1. Because of their great inequality, in so much that the latitude of the first is above 570. English miles, whereas the last of all is scarce a mile.
2. Because that the increase of hours is but a weak ground to build upon, and of no great use: seeing it is as easie to enquire out the length of the day, as the number of the Climate. And therefore hee thinkes, it were farr better, that every Hemisphere were equally distinguished by ten degrees into nine Climates. So that the first Climate should begin at the Equinoctiall, and end where the Elevation of the Pole is ten gr. which might be called the *Aethiopian Climate*. The second should reach to the 20. gr. and should be named the *Arabian Climate*: because that part of Arabia Felix is situated therein. The third should reach to the 30. gr. and be called the *Egyptian*. The fourth the *Syrian*, ending at the 40. gr. The fifth the *Italian*, to the 50. gr. The 6. the *English*, or *Germane*, extending to the 60. gr. The seventh the *Suecian*, or *Lapland Climate*, reaching to the 70. gr. The eighth, the *Frozen Climate*, ending at the 80. gr. And the Ninth and last, the *Polar Climate*, reaching to the Pole it selfe.

So likewise the same Method might bee observed on the other side of the Equinoctiall: and then by this meanes each Hemisphere should have nine Climates: whereof seven would be convenient

ent for habitation, and the Parallels might passe through every fifth degree. And the situation of any place might be known by the number of degrees of the Poles elevation. So Rome, because it hath above 40. gr. of latitude, is in the fourth; Westphalia in the fifth; Sicily in the third; Calcut, the chiefe City in India, in the second; Zilan in the first; and so of the rest.

CHAP. I.

How to find the Longitude, Latitude, Distance, and Angle of Position, or situation of any place expressed in the Terrestriall Globe.



He Ancient Geographers from Ptolomies time downward, reckon the longitude of places from the Meridian which passeth through the *Fortunate Islands*: which are the same that are now called the *Canary Islands*. as the most men do generally believe, but how right y; I will not here stand to examine. I shall onely here advertise the reader, by the way, that the latitude assigned by Ptolomy to the *Fortunate Islands*, faileth something of the widest of the *Canary Islands*, and agreeth a great deal nearer with the Latitude of those Islands which are known by the name of *Cabo Verde* For Ptolomy placed all the *Fortunate Islands* within the 10 gr. 30. m. and the 16. gr. of Northern latitude. But the *Canary Islands* are
○ found

found to bee distant from the *Æquator* at the least 27 degrees. The *Arabians* began to reckon their Longitude, at that place where the *Atlantick* Ocean driveth farthest into the maine land: which place is tenn degrees distant Eastward from the *Fortunate Islands*: as *Jacobus Christmannus*, hath observed out of *Abulfeda*. Our Modern Geographers, for the most part, beginn to reckon the Longitude of places from these *Canary Islands*: yet some beginn at those Islands which they call *Azores*: and from these bounds, are the Longitude of places to be reckoned in these *Globes* whereof we speake.

Now the Longitude of any place, is defined to be, an Arch, or portion of the *Æquator* intercepted betwixt the Meridian of any place assigned, and the Meridian that passeth through *Saint Michaels Island* (which is one of the *Azores*) or of any other place, from whence the Longitude of places is wont to be determined.

Now if you desire to know the Longitude of any place expressed in the *Globe*: you must apply the same place to the Meridian and observe at what place the Meridian cutteth the *Æquator*, reckon the degree of the *Æquator* from the Meridian of *Saint Michaels Island* to that place: for so many are the degrees of longitude of the place you look for.

In the same manner may you measure the distance of longitude betwixt any other two places that are described in the *Globe*. For the difference

difference of Longitude is nothing else, but an Arch of the Æquator intercepted betwixt the Meridian of the same places. Which difference of Longitude, many have endeavoured to set down divers ways how to find by observation. But the most certain way of all for this purpose, is confessed by all learned Writers to be, by the Eclipses of the Moon. But now these Eclipses happen but seldom, but are more seldom seen, yet most seldome and, in very few places, observed by the skilfull Artists in this Science, So that there are but few Longitudes of places designed out by this meanes. *Orotus Finem*, and *Johannes Wernerus* before him, conceived that the difference of Longitude might be assigned, by the known (as they presuppose it) motion of the Moon, and the passing of the same through the Meridian of any place. But this is an uncertaine and ticklish way, and subject to many difficulties. Others have gon other wayes to work: as namely, by observing the space of the Æquinoctiall hours betwixt the Meridians of two places: which they conceive may be taken by the help of Sun Dials, or Clocks, or Houreglasses either with water or sand, or the like. But all these conceits, long since devised, having been more strictly and accurately examined, have been disallowcd and rejected by all learned men, (at least those of ripper judgments) as being altogether unable to performe that which is required of them. But yet for all this, there are a kind of trifling Im-

postors, that make publick sale of these toys or worse, and that with great ostentation and boasting; to the great abuse and expense of some men of good note and quality, who are perhaps better stored with money, then either 'earning or judgment. But I shall not stand here to discover the errors and uncertainties of these instruments. Only I admonish these men by the way, that they beware of these fellows; least when their noses are wiped (as we say) of their money, they too late repent them of their ill-bought bargaines. Away with all such trifling cheating rascals.

PONT. If you would know how to find out the longitude of any place by the Eclipse of the Moon, you must first goe to some Ephemerides, as the P.utenick Tables, or of any other learned Mathematicians calculation; and see, what hour such an Eclipse of the Moon shall happen at that place, for which the said Tables or Ephemerides were made. Then afterward you must observe the same Eclipse in that place, whose longitude you desire to know, Now if the time of the Eclipse agree with that other, for which the Tables were made, then you may conclude that both places have the same latitude, and are situate under the same Meridian. But if the number of the hours be more, then the place you are in, is situate more Eastward, you must therefore subtract the less number out of the greater, and the remainder must be converted into degrees and minutes, multiplying the hours by sixteen and dividing the minutes of hours (if there be any) by four

four; for so will the number of degrees arise: and if there remain any minutes after the division, they must be multiplied again by fifteen, and so will the number of the minutes of degrees arise, by which these places are distant from each other: which distance is called the difference of longitude. This difference must be added to the Longitude of that place for which the Tables were calculated, if the other place be more Eastward: otherwise if it be more Westward, it is to be subtracted from the longitude of the other. An example herof is thus proposed by Adrianus Metius in his Doctrina Sphærica. I find (saith hee) out of the Prutenick Tables, by exact calculation, that there will be an Eclipse of the Moon in the yeare 1598. upon the eleventh day of February, at foure of the Clock and sixteen minutes, in the morning, and that at Regiomont, a City in Borussia, whose longitude or distance from the Canary Islands, is 41. gr. 16. m. For this Longitude where these Tables calculated. Now I set my self to observe this same Eclipse at Marpurg, and find it to happen at three of the Clock and twelve minutes, on the same day of February. Now because the number of hours here is lesse, it appears that Marpurg is more Westward then Regiomont. Therefore I take away a lesse number from the greater, that is, 3. h. 12. m. from 4. h. 16. m. and the remainder is 1 h. 4. minutes: which sheweth the difference of longitude in hours, which makes up sixteen degrees. Therefore I again subtract these degrees of difference from the longitude of Regiomont, as being more Eastward

then Marpurg; and so I find the Latitude of Marpurg from the Canary Island, to be 25. gr. 16. minutes.

C H A P II.

How to find the Latitude of any place.



He latitude of a place, is the distance of the Zenith, or the verticall point thereof from the Æquator. Now if you desire to find out the latitude of any place expressed in the *Globe*, you must apply the same to the Meridian, and reckon the number of the degrees that it is distant from the Æquator: For so much is the Latitude of that place. And this also you may observe, that the Latitude of every place is alwayes equall to the elevation of the same place. For look how many degrees the verticall point of any place is distant from the Æquator, just so many is the Pole elevated above the Horizon: as you may prove by the *Globe*, if you so order it, as that the Zenith of the place be 90. degrees distant every way from the Horizon,

P O N T. Seeing that the Latitude of every place is alwayes equall to the elevation of the Pole: It will not be amisse to shew, how the elevation of the Pole, or the Latitude of any region may be found out, by the observing of the same fixed Star in the Heavens, which is so neare the Pole, as that it never sets in that region: which to doe you must work thus. You must observe both the east and also the greatest altitude of the said Star;

Star; both which must necessarily happen in the Meridian: the least whereof will be beneath the Pole, and the greatest above it. Which done, you must adde the least altitude of it to the greatest; and so the halfe of the degrees thus numbered together, will bee the latitude of the Pole, and latitude of that place. An example whereof may be this. The first Star of the three in the taile of the great Beare is in his least altitude observed at London to be about 11.gr. and the greatest altitude of the same, when it is above the Pole, is found to be neare upon 92. degrees. Both which numbers being added together, do make up 103. halfe of which Summ, namely 51½. is the true elevation and Latitude of London.

CHAP. III.

How to find the distance of two places, and angle of position, or situation.

IF you set your *Globe* in such sort, as that the Zenith of one of the places bee 90. gr. distant every way from the Horizon, and then fasten the Quadrant of Altitude to the Verticall point, and so move it up and down, untill it passe through the Vertex of the other place: the number of degrees intercepted in the Quadrant betwixt the two places, being resolved into furlongs, miles, or leagues, (as you please) will shew the true distance of the places assigned. And the other end of the Quadrant, that

toucheth upon the Horizon, will shew on what wind or quarter of the World the one place is, in respect of the other, and what Angle of Position (as they call it) it hath. For the Angle of Position is that, which is comprehended betwixt the Meridian of any place, and a greater circle passing through the Zeniths of any two places assigned: and the quantity of it, is to be numbred in the Horizon.

As for example. The Longitude of *London* is twenty six degrees, and it hath in Northern latitude 51. degrees, and an halfe. Now if it be demanded, what distance and angle of position it beareth to *Saint Michaels Island*, which is one of the *Azores*: we must proceed thus to find it. First, let the Northern Pole be elevated 51 $\frac{1}{2}$ degrees: which is the latitude of *London*. Then fastening the Quadrant of Altitude to the Zenith of it, that is to say, fifty one degrees and an halfe Northward from the *Æquator*, wee must turne it about, till it passe through *Saint Michaels Island*: and wee shall find the distance intercepted betwixt these two places to be 11. gr. 40. m. or thereabout: which is 280. of our leagues. And if we observe, in what part of the Horizon the end of the Quadrant resteth, we shall find the Angle of Position to fall neare upon 50. gr. betwixt Southwest and by-west, And this is the situation of this Island in respect of *London*.

PONT. The distance of places differing only in latitude may bee found after this manner
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First you must substract the lesser Latitude from the greater, resolving a degree in minutes, if the subtraction cannot be done otherwise conveniently. Then multiply the degrees by 15. and divide the minutes by 4. and the sum produced will be the distance of those two places in common Germane miles, one whereof containeth foure of our English miles. As for example: Basile in Germany and Geneva have both the same longitude. but differ in Latitude, which at Basile is 47. gr. 30. m. and at Geneva 45. gr. 45. m. Therefore subtracting the lesser from the greater, the remainder will bee 1. gr. 45. m. which being reduced into Germane miles, will amount to 26. and a quarter or a mile. which is the distance of these two places assigned.

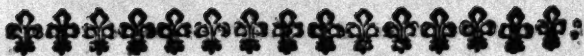
Now if the place proposed bee in diverse Hemispheres, then the degrees and minutes of Latitude must first be added together, and so the whole resolved into miles, as formerly hath been said. As for example: The Cape of good hope in Africa, and Constantinople are almost situate under the same meridian, but in diverse Hemispheres. Now the elevation of the Pole Arctike at Constantinople is 43. gr. or thereabout: and at the Cape of good hope, the Antarctick Pole is elevated about 35. gr. the whole sum therefore is 78. degrees. that is to say 1170. Germane miles.

The distance of places differing onely in longitude, is found thus. First substract the lesse number from the greater: then look in the Table here under written, how many miles answer to a degree in every Parallel, seeking for the degree of Latitude

side in the first column descending, and the number of miles over against it. Then lastly let the difference of longitude be multiplyed into miles and minutes: and you have your desire. As for example; Naples and Ilium or Troy, are in the same latitude of fortie one gr. where eleven Germane miles, and nineteen minutes answer to a degree of that Parallel: but these places differ in longitude, which at Naples is 39. gr. 30 m but at Troy. 55. gr. 50. m. Now the difference betwixt them is 16 gr. 20. m. which is as much as 184. Germane miles, and fifty scruples: the just distance betwixt these two places.



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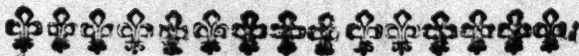
Miles.			
Scrup.	English.	Scrup.	English.
32	18	32	18
33	17	33	17
32	16	32	16
32	15	32	15
31	14	31	14
30	13	30	13
28	12	28	12
27	11	27	11
25	10	25	10
23	9	23	9
21	8	21	8
19	7	19	7
16	6	16	6
14	5	14	5
11	4	11	4
8	3	8	3
5	2	5	2
3	1	3	1
0	0	0	0

Miles.			
Scrup.	English.	Scrup.	English.
35	44	35	44
53	43	53	43
10	43	10	43
16	42	16	42
41	41	41	41
55	40	55	40
9	40	9	40
22	39	22	39
34	38	34	38
46	37	46	37
56	36	56	36
7	36	7	36
16	35	16	35
25	34	25	34
33	33	33	33
41	32	41	32
48	31	48	31
54	30	54	30
0	30	0	30
5	28	5	28
14	27	14	27
18	26	18	26
21	25	21	25
24	24	24	24
27	23	27	23
29	22	29	22
31	21	31	21
33	20	33	20
35	19	35	19
37	18	37	18
39	17	39	17
41	16	41	16
43	15	43	15

Miles.			
Scrup.	English.	Scrup.	English.
51	59	51	59
53	58	53	58
55	57	55	57
56	56	56	56
40	55	40	55
33	54	33	54
25	53	25	53
16	52	16	52
5	51	5	51
54	50	54	50
41	49	41	49
13	48	13	48
17	47	17	47
23	46	23	46
27	45	27	45
31	44	31	44
35	43	35	43
38	42	38	42
41	41	41	41
44	40	44	40
47	39	47	39
50	38	50	38
53	37	53	37
56	36	56	36
59	35	59	35
62	34	62	34
65	33	65	33
68	32	68	32
71	31	71	31
74	30	74	30
77	29	77	29
80	28	80	28
83	27	83	27
86	26	86	26
89	25	89	25
92	24	92	24
95	23	95	23
98	22	98	22
101	21	101	21
104	20	104	20
107	19	107	19
110	18	110	18
113	17	113	17
116	16	116	16
119	15	119	15

A Table of Miles answering to a Degree in each several Latitude.

The Longitude or Latitude, of any place or City being known, either by observation, as hath already been shewed, or else out of some Geographical Table, the situation of the same in the Globe may also be found out by this same meanes. You must first reckon the Longitude of your place, among the circles of Longitude which are described upon the Globe, beginning at that which is drawn through the Fortunate Islands: and observe the circle where you end your reckoning. Then if the Latitude of your place be Northern: you must reckon that also among the Parallels toward the Arctick Pole, beginning from the Equator: but if it have Southern Latitude you must then proceed in like manner, but reckon toward the Antartique. And the intersection, or point where these two circles cut each other, sheweth the situation of your place. But if these circles of Longitude be expressed in your Globe, then must you place that degree of the Equinoctiall, that answereth to the Longitude of your place, under the Meridian, and so reckon the Latitude of your place among the degrees of the Meridian, toward either Pole: and you have the situation of the place you look after.



A Table of Longitudes and Latitudes of some certain Cities of note.

	Longit.	Latti.		Longit.	Latt.
Alexandria	40. 30	43. 42.	Gant	19. 8	51. 24
Amsterdam	21. 43	52. 20.	Graningen	22. 54	53. 16
Antwerp	20. 16.	51. 38.	Heidelberg	25. 28.	49. 35
Athens	52. 45	17. 15	Jena	29. 2	51. 8
Bruxells	20. 42	51. 0	Lubeck	28. 20	54. 48
Bremen	25. 16	53. 40	Leiden	20. 47	52. 10
Bamberg	28. 10.	40. 56.	Regius Mos	46. 45	54. 25
Basell	24. 22.	47. 41.	Boruss.		
Bononia	32. 5	43. 54.	London	25. 50	51. 32
Constantin.	55. 0	42. 5	Marpurg	25. 16.	51. 0
Cassell	28. 26.	51. 43.	Milaine	38. 20	45. 5
Colen	33. 26.	51. 0	Norimberg	20. 20	49. 24
Corinth	31. 15.	36. 55.	Naples	30. 10.	41. 0
Dresden	38. 5	51. 6	Orleans	15. 36	47. 16
Dover	28. 10.	51. 0	Oxford	24. 0	52. 0
Dantzick	39. 2	54. 55.	Prage	37. 0.	50. 6
Dublin	16. 40.	53. 10.	Paris	29. 25.	48. 30
Erford	28. 40.	51. 10.	Ratisbane	29. 50.	49. 55
Estinga	26. 36	48. 39	Rostock	30. 14	54. 36
Francford	25. 38	50. 12.	Spier	35. 29.	49. 20
ad Men.			Tubing	20. 23.	48. 38
Ferraria	32. 15.	44. 23.	Vienna	34. 36.	47. 44
Genna	28. 20	13. 50.	Yorke	23. 30.	54. 30

CHAP. IV.

To find the Altitude of the Sun, or other Stars.

THe Altitude of the Sun, or other Star, is the distance of the same, reckoned in a greater Circle, passing the Zenith of any place and the body of the Sun, or Star. Now that the manner of observing the same is to be performed either by the Cross Staffe, Quadrant, or other like Instrument, is a thing so well known, as that it were vaine to report it. *Gemma Frisius* teacheth a way, how to observe the Altitude of the Sunne by a Sphæricall Gnomon. But this way of proceeding is not so well liked, as being subject to many difficulties and errors: as, whosoever proves it shall easily find.

CHAP. V.

To find the place and Declination of the Sun, for any day given.

HAVING first learned the day of the Month, you must looke for the same in the Calendar described in the Horizon of your Globe. Over against which in the same Horizon, you shall find the Signe of the Zodiacque,

acqu, and the degree of the same, that the Sun is in, at that time. But if it be Leap-year, then for the next day after the 28th of February you must take that degree of the signe, which is ascribed to the day following it. As for example, if you desire to know, what degree of the Zodiack the Sun is in, 29th of February, you must take that degree which is assigned for the first of March and for the first of March, take the degree of the second; and so forward. Yet I should rather counsell, if the place of the Sun be accurately to be known, that you would have recourse to some Ephemerides, where you may have the place of the Sun exactly calculated for every day of the year. Neither indeed can the practise by the Globe, in this case be so accurate, as often times it is required to be.

Now when you have found the place of the Sunne, apply the same to the Meridian, and reckon thereon how many degrees the Sunne is distant from the *Æquator*, for so many will the degrees be to the Sunnes declination for the day assigned. For the Declination of the Sunne, or of any other Starre, is nothing else but the distance of the same from the *Æquator*, reckoned on the Meridian. But the Sunnes Declination may be much more exactly found, out of those Tables which Mariners use, in which the Meridian Altitude, or Declination of the Sun for every day in the year, and the quantity of it is expressed. One thing I shall
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give you notice of by the way; and that is that you make use of those that are latest made, as nere as you can. For all of them, after some certain spaces of time, will have their errours. And I give this advertisement the rather, for that I have seen some, that having some of these Tables, that were very ancient, and written out with great care and diligence, (which notwithstanding would differ from the later Tables, and indeed from the truth it self, often times at least 10. m. and sometimes more) yet would they alwaies use them very constantly and with a kind of religion. But these men take a great deale of paines and care to bring upon themselves no small errours.

PONT You also find out the Suns greatest Declination, by his greatest and least Altitude both in Summer and Winter, by subtracting the least out of the greatest. For then halfe that which remaineth, will be the declination you seek for So Regiomontanus at Vienna found the Meridian Altitude of the Sun, at the Summer Solstice to be 65. gr. 30. m. and the least Altitude of it, on the Winter Solstice, to be 18. gr. 30. m. when therefore; he had deducted the least number, 18. gr. 30. m. out of 65. gr. 30. m. he found the remainder to be 47. gr. 0. m. the halfe of which was the Suns greatest declination, namely 23. gr. 30. m. which is the number of degrees now commonly received: notwithstanding it hath been since observed by some in our time to be somewhat lesse.

Now to know the Longitude of the Sonne for
any

position, the Elevation of either of the Poles, will shew the Latitude of the place where in you are. An example whereof may be this.

On the 12th of *June*, according to the old Julian account, the Sunne is in the first degree of *Cancer*, and hath his greatest declination 23¹ degrees. And on the same day, suppose the Meridian Altitude of the Sunne to be 50. degrees. We enquire therefore now, what is the Latitude of the place where this observation was made. And this wee finde out, after this manner. We apply the first degree of *Cancer* to the Meridian, which wee move up and down, till the same degree bee elevated above the Horizon 50 degrees: which is the Meridian Altitude of the Sunne observed. Now in this position of the Globe, wee find the North Pole to bee elevated 63 gr. and an half: So that we conclude this to be the Latitude of the place, where our observation was made.

The like way of proceeding do Mariners also use, for the finding out of the Latitude of places by the Meridian Altitude of the Sunne, and their Tables of Declinations: But I shall not here speak any further of this, as well for that, the explicatiō hereof doth not so properly concern our present intention: as also because it is so well known to every body, as that the handling of it in this place would be needlesse and superfluous.

The like effect may bewrought in observing the

the Meridian altitude of any other Starre expressed in the *Globe*. For if you set your *Globe* so, as that the Starre you mean to observe, be so much elevated above the Horizon, as the Meridian Altitude of it is observed to be: the elevation of the Pole above the Horizon will shew the latitude of the place. But here I should advise, that the latitude of places bee rather enquired after, by the Meridian Altitude of the Sun, then of the fixed Starres: because the declinations, as we have already shewed, are very much changed, unlesse they bee restored to their proper places by later observations.

Some there are that undertake to performe the same, not only by the Meridian Altitude of the Sun or Starre, but also by observing it at two severall times, and knowing the space of time or Horizontall distance betwixt the two observations. But the practise hereof is prolix and doubtfull: besides that by reason of the multitude of observations that must bee made, it is also subject to many errors and difficulties. Notwithstanding the easiest way of proceeding, that I know, in this kind, is this that followeth.

To find out the Latitude of any place, by knowing the place of the Sun, or other Starre, and observing the Altitude of it two severall times with the space of time betwixt the two Observations.

First having taken with your Compasses the complement of the Altitude of your first Observation, (now the complement of the Altitude is nothing else, but the difference of degrees by which the altitude is found to be lesse then 90 degrees,) you must set one of the feet of your Compasses in that degree of the Ecliptique that the Sunne is in, at that time: and with the other describe a circle upon the superficies of the *Globe*, tending somewhat toward the West, if the observation be taken before noone, but toward the East, if it be made in the afternoon. Then having made your second observation, and observed the space of time betwixt it and the former, apply the place of the Sunne to the Meridian, turning the *Globe* toward the East, until that so many degrees of the *Æquator* have passed by the Meridian, as answer to the space of time that passed betwixt your observations, allowing for every houre fifteen degrees in the *Æquator*, and marking the place in the Parallel of the Suns declination that the Meridian crosses

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seth after this turning about of the *Globe*. And then setting the foot of your Compasses in the very Intersection, describe an Arch of a circle with the other foot of the Compasses extended to the complement of the second observation, which Arch must cut the former circle. And the common Intersection of these two circles, will shew the vertical point of the place where-in you are: so that having reckoned the distance of it from the *Æquator*, you shall presently have the latitude of the same.

The same may be effected, if you take any *Starre*, and work by it, after the same manner; or if you describe two circles mutually crossing each other, to the complements of any two *Starrs*.

PONT. *The Meridian altitude of the Sunne, being found by the help of of the Meridian circle, it will be very easie to find out the latitude of the place or elevation of the Pole, in vny region whatsoever. For seeing the Zenith or Vertex of every place is distant a quarter of a circle that is 90. degrees from the Horizon: if then, the Sun being in either of the Æquinoctiall points, the Meridian altitude be substraetted from 90 degrees; the remainder wil be the distance betwixt the Zenith of the place and the Æquinoctiall circle: which will be the latitude of the same place. And the reason also of this deduction is manifest, because that the Æquinoctiall Altitude of the Sun, is nothing else, but the Elevation of the Æquator, the complement whereof is always equall to the elevation of the Pole. But this will appear more plaine by an*

example, which shall be thus. The *Æquinoctiall* altitude of the *Sunne* at *Rome* is 40. degrees: which being subtracted from 90 gr. the remainder, which is 42. gr. is the elevation of the Pole, and the latitude of *Rome*. So likewise here at *London* in the *Meridian* altitude of the *Sunne*, when he is in the *Æquinoctiall*, is found to bee 38 degrees and an half: which being deducted out of 90 gr. which is the *Quadrant* of a circle, there will remain 15½ gr. which is the latitude of *London*, and the elevation of the Pole.

The same also may be done, by observing any one of the fixed *Starres*, which is so neare the Pole, as that it never sets in that Country, whose latitude you seek. For you must observe both the greatest and least altitude of the same *Starre*; both which will happen in the *Meridian*: the least of them beneath the Pole, and the greatest above it. Which done, you must adde the least altitude to the greatest, and so dividing the whole into two parts, the half will be the altitude of the Pole. As hath been shewed before.



CHAP. VII.

How to find the Right and Oblique Ascension of the Sunne and Starrs, for any Latitude of place, and time assigned.

THe Ascension of the Sun or Starr, is the degree of the Æquator that riseth with the same above the Horizon. And the Descension of it, is the degree of the Æquator, that goes under the Horizon with the same. Both these is either Right, or Oblique. The Right Ascension or Descension is the degree of the Æquator that ascendeth or descendeth with the Sunne, or other Starre in a Right Sphære : and the Oblique is the degree that ascendeth, or descendeth with the same in an Oblique. The formes of these is simple and of one kind only : because there can be but one position of a Right Sphære. But the later is various and manifold, according to the diverse Inclination of the same.

Now if you desire to know the Right Ascension or Descension of any Starre, for any time and place assigned apply the same star to the Meridian of your *Globe* : and that degree of the Æquator that the Meridian crosseth at that situation of the *Globe*, will shew the Right Ascension and Descension of the same, and also divideth each Hemisphere in the midst at the same time with it.

And if you would know the Oblique Ascension or Descension of any Starr, you must first set the *Globe* to the latitude of the place, and then place the Starre at the Easterne part of the Horizon: and the Horizon will shew in the *Æquator* the degree of Oblique Ascension. And if you turn it about to the West side of the Horizon, the same will also shew in the *Æquator* the Oblique Descension of that Star. In like manner you may find out the Oblique Ascension of the Sun. or any degree of the *Eclipticke*, having first found ou, in the manner we have formerly shewed the place of the Sun. And hence also may be found the difference of the Right and Oblique Ascension, whence ariseth the diverse length of dayes.

As for example, The Sunne entreth into Capricorn on the eleventh day of *December*, according to the old account. I would now therefore know the Right and Oblique Ascension of this degree of the *Ecliptick*, tor the latitude of fifty two degrees. First therefore, I apply the first degree of Capricorn to the Meridian: where I find the same to cut the *Æquator* at 270. gr. which is the degree of the Right Ascension. But if you set the *Globe* to the Latitude of fifty two degrees, and apply the same degree of Capricorn to the Horizon; you shall find the 303 gr. 50. m. to rise with the same. So that the difference of the Right Ascension 270. and the Oblique 303. gr. 50. m. will be found to be 33. gr. 50. minutes.

PONT,

PONT. This Ascension and descension is also called the Astro nomicall rising and setting of the Stars: and that in respect of the Arches and parts of the Ecl ptick, or Stars, either above or beneath the Horizon. Now an Arch of the Ecliptick or Zodiacke is to be understood two manner of ways namely Continued, or Discrete. A continued Arch, is when it is reckoned in the Equator in a continued Series from the beginning of Aries, and so forward into the consequent signes. A Discrete Arch is so called because it is not reckoned from the first degree of Aries, but from any other point in the Equator: as if you should say, an Arch from the 14. gr. of Gemini to the 14. gr. of Taurus.

Beside, this Right Ascension is called also the greater Ascension, because that in it, a greater Arch of the Equator riseth above the Horizon, then of the Zodiack: & it is called Right, because that in this, the Angle which is made by the Horizon and Eclipticke, is nearer to a Right Angle, then that that is made by any other part of the Eclipticke with the same. And that is said to be a greater Arch or portion of the Equator, which is more than 30. degrees in the Ascension or Descension: and that is called a lesser Arch, which falls short of thirtie, degrees in rising or setting.

In a Right Sphere foure signs onely ascend Rightly, which are Gemini, Cancer, Sagittarius and Capricornus: all the rest ascend Obliquely.

In an Oblique Sphere six signes rise Rightly
and

and the other six Obliquely. The right are these, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius: and all the rest Obliquely.

Oblique ascension, is when a lesse Arch or portion of the *Æquator* riseth, then of the *Zodiague*: or else, that *Starre* may be said to rise Obliquely, with whom a lesse portion of the *Æquator* ascendeth above the *Horizon*. And so the Oblique descention or setting of a *Starre* is, where a lesse portion of the *Æquator* descendeth with it. As for example. At *Rome* with the Arch of *Libra*, which containeth 30. gr. in the *Zodiague*, there riseth an arch of the *Æquinotiall* of 37 gr. So that this sign is said there to rise rightly: Because that a greater Arch of the *Æquator* ascendeth with it, then of the *Zodiague*, But then, at the same place, with the Arch of *Aries*, there arise only 17. gr. of the *Æquator*. Whence it followeth that *Aries* riseth Obliquely at *Rome*. In our position of *Sphere* also here at *London*, which is Oblique, like as that at *Rome* with *Libra* there ariseth an Arch of the *Æquinotiall* containing about 41. gr. but with the Arch of *Aries* there ariseth not above 13. degrees. Therefore in our *Sphere* *Libra* ascendeth or riseth rightly, but *Aries* Obliquely.

Certain Rules, for the Astronomicall rising in a right Sphere.

THe Rules of Astronomicall rising in a right Sphere are these. 1. The whole Quadrants or quarters of the *Zodiague* and *Æquinotiall* rise

rise and set in an equall space of time. 2. But the the parts of the Quadrants rise and set unequally. 3. Those signes that are equally distant from any of these points, have also equall ascensions: as Gemini and Cancer. 4. The Ascension of a sign is alwayes equall to the Descension of the same. 5. Four signs only rise rightly, namely Gemini, Cancer, Sagittarius, and Capricornus: and all the rest Obliquely.

Rules for the Astronomicall rising in
an Oblique Sphere.

IN an Oblique Sphere, the two halves that begin at the two Equinoctiall points, do rise together. 2. The parts of these halves do rise unequally. 3. Those signes that rise rightly, descend Obliquely, and so contrarily. 4. The Ascension of any sign is equall to the Descension of the same. 5. The Ascensionall Arches of the Northern signes are lesse in a right sphere, but in the Southerne signes they are greater. 6. The Ascension of Opposite signes in an Oblique Sphere, taken together, are equall to the Ascension of the same in a right Sphere. 7. Those signes that are equidistant from either of the Equinoctiall points, have equall Ascensions, because they decline equally from the Equator.

CHAP. VIII.

How to finde out the Horizontall difference betwixt the Meridian and the Verticall circle of the Sunne, or any othe Starre, (which they call the Azimuth,) for any time or place assigned.

HAving first observed the Altitude of the Sunne or Starre that you desire to know, set your *Globe* to the Latitude of the place you are in: which done, turne it about, till the place of the Sun, or Starre which you have observed, be elevated so much above the Horizon, as the Altitude of the same you before observed. Now you shall find that you desire, if you take the Quadrant of altitude, and tassen it to the Verticall point of the place you are in, and so move it together with the place of the Sunne or Starre up and downe, untill it fall upon that which you have set down in your instrument at your observation. Now in this situation of the Quadrant, that end of it that toucheth the Horizon, will shew the distance of the Verticall circle, in which you have observed the Sunne or Starre to be, from the Meridian. As for example.

In the Northern latitude of 51. gr. on the 11th. of *March* after the old account, at what time the Sunne entreth into *Aries*, suppose the altitude of the Sun before noon to be observed

ved to be thirtie gr. above the Horizon. And it is demanded, what is the *Azimuth*, or distance of the Sun from the Meridian. First therefore having set the *Globe* to the Latitude of 51. gr. and fastening the Quadrant of Altitude to the Zenith, I turne the *Globe* about, till I find the first degree of *Aries* to be 30 gr. above the Horizon. And then the Quadrant of Altitude being also applied to the same degree of *Aries*, will shew upon the Horizon, the *Azimuth* of the Sun, or distance of it from the Meridian, to be about fortie five degrees.

CHAP. IX.

How to find the hour of the day, as also the Amplitude of rising and setting of the Sun and Starres, for any time or Latitude of place.

THe Sunne, we see, doth rise and set at severall seasons of the yeare, in diverse parts of the Horizon. But among the rest it hath three more notable places of rising and setting. The first whereof is in the *Æquator*, and this is called his *Æquinoctiall* rising and setting. The second is in the Summer Solstice, when he is in the Tropique of *Cancer* : and the third is in the Winter solstice, when he is in the Tropique of *Capricorne*. Now the *Æquinoctiall* rising of the Sun is one and the same in every Climate

Climate. For the *Æquator* alwayes cutteth the *Horizon* in the same points, which are alwayes just 90 gr. distant on each side from the *Meridian*. But the rest are variable and change according to the diverse inclination of the sphere: and therefore the houres are unequal also.

PONT. And here you are to understand, that the *Amplitude* of the *Sunnes* rising and setting, is an *Arch* of the *Horizon* intercepted betwixt the *Æquator*, and the place of the rising and setting of the *Sun*. And it is either *Northerne* or *Southerne*. The *Northern Amplitude*, is when hee sets and riseth on this side of the *Æquator*, toward the *North Pole*: and the *Southern* when he sets or riseth on the contrary side. Now when the *Sun* is in the *Æquator*, he hath no amplitude at all: but when he is in the *Solsticall* points, he hath then the greatest amplitude of all; of which that in the *Tropic* of *Cancer* is called the *Æstivall*, or *summer solsticall* amplitude; and the other the *Brumall* or *Winter solsticall* amplitude.

And here it is to be noted that in all places the *Ortive* amplitude of any *Starre* is equall to the *Occidentall* amplitude of the same. And likewise, that two stars being equally distant from the *Æquator* the one *Northward*, and the other *Southward*, or both of them *Northward* or *Southward*, have equal amplitude of rising and setting.

Now if you desire to know the *houre*, or *distance of time*, betwixt the rising and setting of the *Sunne*, when he is in either of the *Solstices*;

slices, or in any other intermediate place, and that for any time or latitude of place: you shall work thus. First, set your *Globe* to the latitude of your place; then having found the place of the sunne, for the time assigned, apply the same to the Meridian, and withall you must set the point of the Houre-Index at the figure twelve in the Houre-circle. And having thus done, you must turn about the *Globe* toward the East part, till the place of the sunne touch the Horizon: which done, you shall have the Amplitude of the sunns rising also in the *Æquator*, which you must reckon, as we have said, from the East point, or place of intersection betwixt the *Æquator* and Horizon. And then if you but turn the *Globe* about to the West side of the Horizon, you shall in like manner have the hour of his setting, and Occidental Amplitude.

And if at the same time, and for the same latitude of place, you desire to know the hour and Amplitude of rising and setting, or the greatest elevation of any other starre expressed in the *Globe*: you must turne about the *Globe*, (the Index remaning still in the same position, and situation of the Index as before) till the said starre come to the Horizon, either on the East or West: and so shall you plainly have the hour and latitude that the starre riseth or seteth in, in like manner as you had in the sunne. And then if you apply the same to the Meridian, you shall also have the Meridian Altitude of the same starre. An example

example of the Amplitude of the Sun's rising and setting may be this.

When the Sunne enters into *Taurus* (which in our time happens about the eleventh of *April* according to the *Julian* account) I desire to know, the hour and Amplitude of the Sun's rising, for the Northern latitude fiftie one degrees. Now to find out this, I set my *Globe* so, that the North Pole is elevated above the Horizon fiftie one degrees. Then I apply the first degree of *Taurus* to the Meridian, and the Hour-Index to the twelfth hour in the Hour-circle. Which done, I turn about the *Globe* toward the East, till that the first degree of *Taurus* touch the Horizon: and then I find that this point toucheth the Horizon about the twenty fift degree Northward from the East point. Therefore I conclude that to bee the Amplitude of the Sunne for that day. In the mean time, the Index strikes upon halfe an hour after four: which I take to be the time of the Sunnes rising.

CHAP. X.

Of the threefold rising and setting of Stars.

BESIDES the ordinary Emerſion and Depreſſion of the Starres in regard of the Horizon, by reaſon of the circumvolution of the Heaven: there is alſo obſerved a threefold riſing & ſetting

ing of the Starre. The first of these is called in Latine, *Ortus Matutinus*, five *Cosmicus*, the Morning, or Cosmicall rising, the second *Vesperinus*, five *Achronicus*, the Evening, or Achronicall : and the last *Heliacus*, vel *solaris*, Heliacall or Solar. The Cosmicall or morning rising of a Starre is, when as it riseth above the Horizon together with the Sunne. And the Cosmicall or morning setting of a Starre is, when it setteth at the Opposite part of heaven; when the Sunne riseth. The Acronychal or Evening rising of a Starre is, when it riseth on the Opposite part, when the Sunne setteth. And the Acronychall setting of a Starre, is when it setteth at the same time with the Sun. The Heliacall rising of a starre (which you may properly call the Emerfion of it) is, when a starre that was hid before by the Sun beams beginneth now to have recovered it selfe out of the same, and to appear. And so likewise the setting of such a starre (which may also fitly be call'd the occultation of the same) is, when the Sun by his own proper motion overtaketh any Starre, so that by reason of the brightnesse of his beams it can no more be seen.

PONT. Concerning the rising and setting of the Starrs, which is considered in respect of the Horizon and Æquator, hath been spoken already in the seventh Chapter : where we also shewed, that that kind of rising and setting of the Starres was called astronomicall. But in this place the rising of the Starres is considered in relation one

to the Horizon and Sunnes aspect, but not of the Equator; and therefore it is also commonly called, the Poeticall rising and setting of the Stars.

Now as touching the last of these kinds, many Authors are of opinion that the fixed Stars of the first magnitude do begin to shew themselves after their Emerſion out of the Sunne-beames, when as they are yet in the upper Hemisphere, and the Sun is gone down twelve degrees under the Horizon. But these of the second magnitude require that the Sun is depressed 13, gr. and those of the third, require fourteen; and of the fourth, fifteen; of the fifth, sixteen; of the sixth, seventeen, and the cloudy and obscure Starres require eightene degrees of the Suns depression. But *Ptolomy* hath determined nothing at all in this case: and withall very rightly gives this admonishment, and *lib. 8. cap. ult. Almag.* that is a very hard matter to set down any determination thereof. For as he there well noteth, by reason of the unquall disposition of the air, this distance also of the Sunne, for the Occultation and Emerſion of the Starres, must needs bee unquall. And one thing more we have to encrease our suspicion of the incertainy of this received opinion, and that is, that *Vstello* requireth nineteen degrees of the Suns depression under the Horizon, before the Evening twilight be ended. Now that the obscure and cloudy Starre, should appeare ever, before the twilight be down, I shall very hardly be persuaded

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swaded to believe. Notwithstanding how-
ever the truth of the matter be, wee will fol-
low the common opinion.

Now therefore if you desire to know at what
time of the year any Starre riseth or setteth in
the morning or the evening in any Climate
whatsoever: you may find it out thus. First,
set your Globe to the latitude of the place you
are in, and then apply the Starre you enquire
after, to the Eastern part of the Horizon and
you shall have that degree of the Eclipticke;
with which the said Starre riseth Cosmically,
and setteth Acronychally: and on the oppo-
site side, on the West, the Horizon will shew
the degree of the Ecliptick, with which the
same Starre riseth Acronychally, and setteth
Cosmically. For the Cosmical rising, and
Achronicall setting and so likewise the Acro-
nycall rising, and Cosmical setting of a
Starre are all one: according to those old
verses,

*Cosmicè descendit signum, quòd Acronychè
surgit.*

*Chronychè descendit signum, quòd Cosmici
surgit.*

But these things are to bee explained more
fully. For a Starre doth not always rise and
set with the same degree of the Eclipticke.
For the Southern Starrs do anticipate the de-
gree with which they rise, at their setting:
but the Northern Starrs come after it: that
is, if the elevation be of the Arcticke Pole.

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Otherwise it is quite contrary, if the South Pole be elevated. Now having found the degree of the Ecliptick with which the Star you enquire after, doth rise and set; if you seek for the same degree of the signe in the Horizon of your Globe, you shall presently have the moneth and day expressed, wherein the Sunne commeth to the same degree and signe.

And as for the Heliacall rising and setting of a starre, you may find it thus. Having set your Globe to the Latitude of your place, you must turn about the starre proposed to the West side of the Horizon, and withall on the opposite East part observe what degree of the Ecliptick is elevated above the Horizon 12, 13, 14. or any other number of degrees, that the magnitude of your Starre shall require for distance from the Sunne. And when the Sun shall bee in the Opposite degree to this, then that starre will set Heliacally, that is to say, it will bee quite taken out of our sight by the brightnesse of the Sunne beames. Now, if on the other side, you apply the same starre to the East, and finde out the Opposite degree in the Eclipticke on the West part; that is, the same number of degrees above the Horizon: when the sunne commeth to this place, the same starre will rise Heliacally, or recover it selfe out of the sunnes beames. And so, if you but finde the same degrees of the Eclipticke among the signes on the Horizon of your Globe, you have the Moneth and the day
when

when the Sunne will be in those degrees. And the same also is the time of the Emerſion and Occultation of the Starre you enquire after. But we will here propoſe an example of the Occultation of ſome fixed Starre of the firſt magnitude: which done, the Emerſion of the ſame is alſo found by the contrary way of working.

And the Starre wee propoſe, ſhall be, that bright Starre in the mouth of the Great Dog, which is called *Sirius*: whoſe Occultation we deſire to know for the Latitude of 51. gr. Northward. Now this Starre, being of the firſt magnitude, begins to bee hid, whenas it toucheth the Horizon in the upper Hemisphere, and the Sunne is at the ſame time depreſſed under the Horizon but 12. degrees. If therefore you apply this Starre to the Weſt part of the Horizon (having firſt ſet your Globe to the latitude of 51 degrees) and on the Oppoſite Eaſt ſide, obſerve what degree of the Eccleſticke is juſt 12 degrees above the Horizon (now this degree is very neare the 11. gr. of *Scorpius*) when the Sunne ſhall come to the Oppoſite degree in the Eccleſticke, which is the 11. of *Taurus*, that Starre will ſet Heliacally, and be hid by the Sun-beamer. But the Sun comes to this degree of *Taurus* about the 22. of *Aprill*: therefore wee conclude that the Dogge Starre ſets Heliacally about that time. And if you worke in the ſame manner, applying the Starre to the Eaſt part of the Horizon, you ſhall have the time of

its Heliacal rising or Emerſion out of the Sunne beames.

Not unlike this, is the manner of proceeding alſo in finding the beginning and ending of the twilightes: of which we ſhall ſpeak in the next Chapter.

PONT. *The uſe and benefit of this diſcourſe concerning theſe kinds of riſing and ſetting of the Starres is principally ſeen, in reading of the ancient Authors and Poets, eſpecially thoſe that have written of Husbandry, and the ſeverall ſeaſons of the year. For ſo Virgil. lib. 1. Georg. makes mention of the Coſmicall riſing of the Starres in theſe verſes.*

Candidus auratis aperit cum cornibus annum.

Taurus, & adverſo cadens Canis occidit aſtro.

Which is thus Engliſhed by T. May.

[*When, with his golden horns bright, Taurus opes,*

The year: and downward the croſſe Dog-ſtar ſtoopes.

In which place hee meaneth to intimate the moneth of April, when as the Sunne is in the ſign Taurus and riſeth with it. And we have an example alſo of the Coſmicall ſetting in the ſame place, where he ſaith,

*At ſi triticeam in meſſem, robuſtaq; farra
Exercebit humum ſoliſque inſtibus ariſtis.*

*An è tibi Fœx Atlantides abſcondantur,
Gnolâque ardentis decedat ſtella corona,
Depita quam ulcis cômuitas ſemina, quamq;
Invigil*

Celestiall and Terrestriall Globe.

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*Invita properas anni spem credere terræ.
Multant cunctum Malu capere; sed illos
Expectata seges vanis eluit avenis.*

Thus rendered by T. May.

*But if thou plough, to sowe more solid grain,
A whiat or barley harvest to obtain:
First let the morning Pleiades be set,
And Ariadne's shining Coronet,
Ere thou commit thy seed to ground, and there
Dare trust the hope of all the following year.
Some that before the fall 'orth Pleiades
Began to sowe, deceived in the increase,
Have reapt wild oates for wheat, &c.*

Where bee would have them to expect their sowing time, till that the Altantide, that is, the Pleiades, or seven Starres be hid in the East, that is, in the Morning by the approach of the Sunne, which is also called Occidus Colmicus. At which time also the bright Starre in the Northern Crown sets in the Evening with the Sunne, or Heliacally. and so the Poet, by a twofold kind of setting of the Starrs, describes the 28. and 29. of October.

An example of the Achronycall rising you have in Ovid. lib. 1; de Ponto Eleg. 9. where he describeth the tediousness of his exile, from the Autumnall or Vespertine rising of the Pleiades, in words.

*Ut careo vobis Sythicas detrusus in oras:
Quatuor Autumnos Pleïas orta facit.*

In English thus.

*Since of your joyfull sight cold Scythia me depriv'd
The rising Pleiades four Autumnes have reviv'd.*

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And

And he also mentioneth the Achronicall setting,
lib. 2. Factor : where speaking of the third of Fe-
bruary, he doth it by this Periphrasis,
Quem modo celatum stellis Delphina videbas,
Is iugiet visus nocte sequente tuos.

That is to say.

The Dolphin earst with Stars you saw bedight,
The next night vanisheth out of your sight.
An example of the Heliacall rising in February
you have in the same Author, in these words.
Tertia nox veniet, custodem protinus ursæ,
Aspicies geminos exeruisse pedes.

Which may be Englished thus.

When now the third night comes, you shall perceive
Arctophylax will both his feet up heave.

And for the Heliacall setting, you had an in-
stance above, out of Virgil. Georg. 1.

—Et aduerto cadens canis occidit astro.

In which place the Poet speaketh of sowing
millet and beans in the spring time. To these wee
may also adde these severall kinds of Poeticall ri-
sing and setting of Starres exprest.

Cosmicus est ortus, cum sol emergere quatit.

Iphius oppositum lapsus, ad ima gerit.

Chronicus est lapsus, cum sol in vespere tabet.

Iphius oppositum Chronicus ortus habet.

Heliacus signo datur ortus sole remoto.

Ilius occasum proximitate noto.

CHAP. XI.

*How to finde the beginning and end of the
Twilight, for any time and Latitude of
place.*

THe *Twilight* is defined to bee a kind of imperfect light betwixt the Day and the Night, both after the setting; and before the rising of the Sunne. Of which the first is called the *Evening Twilight*, and the other the *Morning*. Now the beginning of the one, and the ending of the other are perceived at the same equal space of time from the rising and setting of the Sun: notwithstanding the continuance of each of them is sometimes greater, and sometimes lesse. For in Summer the *Twilights* are much longer then in the Winter. The measure of them they commonly make to be, whenas the Sunne is depressed 18 degrees under the Horizon. But, as P. *Nonius* rightly observeth, there cannot bee any certain Measure or Tearme assigned them by reason of the various disposition of the air, and the elevation of the vapours that are exhaled out of the earth; which the same Author saith, he findes to be also diverse, sometimes higher, and sometimes lower. *Vitelio*, and *Albazenus* before him, would have it to bee when the Sun is depressed under the Horizon
nine-

nineteen degrees. But how ever the truth be, we shall follow the common received opinion herein. Now therefore, if you desire to know upon these grounds here laid down, at what hour the Twilight begins and endeth, at any time or latitude of place; you must do thus. First, set your *Globe* to the latitude of that place, and apply that degree of the *Ecliptick*, wherein the *Sunne* is at that time, to the *Meridian*, and withall direct the point of the *Index* to twelve in the *Hour-circle*: Then marking the degree of the *Eclipticke*, that is directly opposite to the place of the *Sun*, turn about your *Globe*, till such time as the opposite degree of the *Sunne* be elevated eighteen gr. above the *Horizon* toward the *West* part of it: and forthwith the *Index* will shew in the *Hour-circle* the beginning of the *Morning Twilight*. And if you turn about your *Globe*, in like manner, to the *East*, you shall also have the hour when the *Evening Twilight* endeth.

PONT. Our Northern regions have their *μακρυαυγαις*, or *Twilight*, of above an houre long. But those Countries, where the *Tropicke* are very farre beneath their *Horizon*, have in a manner no *μακρυαυγαις*, no *Twilight* or breake of day. And therefore those that inhabit neare the *Æquator*, have not the beginning nor later part of the night enlightened at all, neither is there any appearance of light, before the *Sunne* bee risen. Whereas, on the contrary side, those that have the *Tropicke* very neare their *Horizon*, must necessa-

rily

rily have Twilight almost all the night long in Summer. And therefore when the Romans came into Brittain, and perceived that, at the Summer Solstice, their nights were light almost all the night long: they did not account this Twilight to be night, but said, *Minimâ nocte contentos Britannos*, that the Britains were contented with a very short night.

Now this *ὑπὸ νύκτι*, as it is defined by Joseph Scaliger upon Manilius, is nothing else but *ὑπὸ νύκτι ἀντιστάσις*, a kind of Antiperistasis, or Circumstipation (as we may call it) of the light: which can be none at all, in those places, where the Tropicke and Horizon, are farre distant. For this *ὑπὸ νύκτι*, as Scaliger in that place accurately observeth, is onely found under those signes which are neare the Solstitiall point, as Gemini and Cancer; and that in those Countries too, where the night is somewhat larger, then it is under the Pole of the Ecliptick: as for example. (to use Scaligers own words) those that have not the Tropicke for their Articke circle, nor where it toucheth the North point of the Horizon; with them the night is so long darke, as while the Tropicke commeth to strike upon the North point of the Horizon. As wee know it hapneth in Scotland where our Countreymen that were Souldiers there, could see to play at dice all night long without any Candle, about the time that the daies were at the longest. Now the Tropick is distant from the Horizon at Edensburge 9. gr. 17. m. or thereabout. And therefore so much is the distance betwixt the Sun and their Horizon at midnight in
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the Summer Solstice: so that necessarily the rest of the night must bee Twilight, and of 6. houres, 23. minutes, which is the length of their night, wit above 37 m. which is not much above halfe an hour, are quite dark: and all the rest of the night is light. Whence you may perceive the reason of the long continuance of the day in those regions, that have the Tropicke neare bordering on their Horizon. And therefore the Romans being not well acquainted with this Antiperistasis of the light, thought that in those parts they had but scarce any night at all. And hence it necessarily followes, that by how much the Tropick is more remote from the Horizon, by so much are the nights lesse enlighthned: and those that inhabite neare the Equinoctiall are so farre from having their day extended farther, either before the Sun rises, or after it sets, as that with them there is no appearance of light at all, before the Sun is up. And there is scarcely any Twilight or dawning of the Day at all in those regions that lye within tenne, degrees of the Equinoctiall: for which there can be no other reason given, but onely the distance betwixt the Tropicke and their Horizon. And if they have no Twilight in the Summer, how much lesse will there be any when the Sun is in the other Tropicke. So that we have no reason to give any credit to Alosiyus Cadamustus, who when he had occasion to write of this argument, gave this to be the reason of it, because there are no mountaines there to hinder, but that the Sun may be seen at the instant of his rising. But this is a ridiculous reason, and not worthy a confutation. Thus Scaliger.

Chap.

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CHAP. XII.

How to find the length of the Artificiall Day or Night, or quantity of the Sunnes Parallel that remains above the Horizon, and that is hid beneath it, for any Latitude of place and time assigned. Als also to find the same of any other Starre.

THe Day we have already shewed to be twofold; either Naturall, or Artificiall. The Naturall Day is defined by the whole revolution of the Æquator, with that portion also of the same that answereth to such an Arch of the Eclipticke, which the Sunne passeth over in one day. Now the whole revolution of the Æquator (besides that portion which answereth to the Sunnes proper motion) is divided into twentie foure equall parts, which they call equall hours: because they are all of equal length, fifteen degrees of the Æquator rising, and as many setting every houres space. Now the beginning of this Day being diverse, according to the diversity of Countries, (some beginning it at Sun-set, as the *Athenians* and *Jewes*: some at midnight, as the *Egyptians* and *Romanes*; others at Sun-rising, as the *Chaldeans*; or at Noon, as the *Umbrians*, and commonly our Astronomers do at this day:) this being not a thing suitable to our present purpose

purpose, I shall not proceed any further in the explanation of the same.

The *Artificiall day* is defined to bee, that space of time that the Sun is in our upper Hemisphere : to which is opposed the *Artificiall Night*, while the Sun remaineth in the lower Hemisphere. The *Artificiall day*, as also the *Night*, are divided each of them into 12 parts, which they call unequal hours: because that according to the different seasons of the year, they are greater or lesse, and are never always of the same length.

The length of the *Artificial day* is thus found out. The *Globe* being set to the latitude of the place, you must find out the degree of the *Ecliptick* that the Sun is in at that time, and apply the same to the *Meridian*, and direct the *Hour-Index* to the number of 12, in the *Circle*. And then turning about the *Globe*, till that the place of the Sun touch the *Horizon* at the *Easterne* part, the *Index* will shew the hour in the *Circle* of the rising of the Sun : and if you but turn it about again to the *West*, you shall, in like manner, have the hour of his setting, and so by this means find out the length of the *Artificiall day*. Now if you multiply the number of the hours by 15. (for so many degrees, (as we have already often said) are allowed to one equall *Æquinoctiall* hour) you shall presently have the number of degrees of the Sun's *Parallel* that appears above the *Horizon* : which if you substract out of 360. the remainder will bee the quantity of that part of

of the same Parallel, that alwayes is hid under the Horizon. Or else you may proceed the contrary way, and first find out the quantity of the Diurnall Arch, and afterward by the same, you may gather the number of the hours also. For the *Globe* being set to the latitude of the place, and the degree of the Eclipticke that the Sunne is in, being known, you may find out, in the manner now set down, the difference of the Right and Oblique Ascensions of the same degree of the Eclipticke, for the Latitude of that place. For this difference will be the half of that, wherein the Artificiall day, for that time and place, is either deficient, or exceeds the length of our Æquinoctiall day. And therefore you must add it, when the dayes are longer then the nights, (which is from the 11th. of *March*, to the 12th. of *September* :) but substract all other times of the year, when as the nights are longer then the dayes.

As for example. On the 12 day of *June*, according to the old account, the Sunne enters into *Cancer* : the Right Ascension of which degree of the Ecliptick is 90. degrees. But if in the latitude of 52 gr. the first degree of *Cancer* bee applied to the Horizon, we shall finde the Oblique Ascension of it to be fiftie fixe gr. and about tenne *m*. So that the difference betwixt them is 33. gr. 50. *m*. which if you adde to nintie gr. the halfe of the Æquinoctiall day, the length of the Artificiall day will then bee 123. gr. fiftie *m*.
and

and the whole Diurnall Arch 247. gr. 40. mi. which if you divide by fifteen, the quotient will be sixteen and almost an halfe : which is the number of houres in the Artificiall day on the twelfth of *June*, for the latitude of fiftie two degrees:

And by this means, may you also find out the quantity of the longest, or shortest, or any other intermediate day, together with the increase and decrease of the same, for any time or latitude of place.

Cleomades would have the quantity of the dayes to increase and diminish after this manner: that the month immediatly before and also after the *Æquinox*, the days should increase and decrease the fourth part of the whole difference betwixt the length of the longest and the shortest dayes of the whole yeare : and the second moneth they should differ a sixth part ; and the third a twelfth part : that is, if the whole difference betwixt the longest and the shortest day bee sixe houres. So that the moneth going immediatly before, and after the *Æquinox*, the dayes increase and decrease an hour, and an half, that is to say, the fourth part of 6. hours : the second month an whole hour ; and the third month half an houre. But suppose we this to be exactly agreeable to some certain determinate latitude ; yet it is not generally so in all places. For according to the diverse Inclination of the Sphære, the days also are observed to increase and decrease diversly. For seeing that the Parallels in every severall

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severall Latitude are cut by the *Æquator* in a different manner, it must needs follow, that the proportion of the increase and decrease of the dayes must be also different.

I shall not here need to set down the manner, how to find the apparent Arch of the Parallel of any Star: seeing that it is found out in the same manner, as the Diurnall Arch of the Suns Parallel is.

C H A P. XIII.

How to find out the houre of the Day and Night; both equall and unequall, for any t. m. and Latitude of place.

IF you desire to find out the equall hour of the Day, first set your *Globe* to the latitude of the place you are in: and also observe the latitude of the Sun. Which done, apply the place of the Sunne, to the Meridian, and set the Index to the twelfth hour in the Circle: and then turn about the *Globe* either to the East, or West, as your observation shall require, untill that the place of the Sunne be elevated so many degrees above the Horizon, as shall agree with your observation: as hath been already shewed, in declaring how to find the *Azimuth*. And the *Globe* standing in this situation, the Index will point out in the Hour-circle the hour of the day, where- in your observation was made. After the

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same manner also you may find the hour of the night, by observing the Altitude of any known Star, that is exprest in the *Globe*. For the Index must stand still, as it did before, when it was fitted to the place of the Sun: and the *Globe* must be turned about, till the Star bee observed to have the same Elevation above the Horizon of the *Globe*, as it had in the Heavens, and then the Index will shew the hour of the Night.

Now the manner how to find out the unequal hour of the day, is this. First you are to find out, as we have already shewed, the quantity or number of the houres of the *Artificiall day*, and also the equal hour of the same: whence by the Rule of Proportion, you may also come to the knowledge of the unequalle houre.

PONT. *The unequalle hours do answer to the Artificiall day, which, as you have heard before, is defined to be the space of time that the Sun remains in the upper Hemisphere: to which is opposed the Artificiall night, comprehending all that time, while the sun is hid from us. Which space of time, seeing that it is always divided into 12. parts, (which they call unequalle hours:) the day it self being at diverse seasons of the year of different length, the hours it contains must also bee unequalle. So likewise on the other side, the equalle houres do agree to the Naturall day, which is defined by the whole and perfect revolution of the Equator: And this also is divided into 24. equalle parts, which are therefore called equalle houres, because*

cause they are alwayes of equall length, fifteen degrees of the *Æquator* rising & setting every hour. For the whole *Æquator* being divided into 24. parts, there are contained in the revolution of it 15. parts of time, which is the measure of an hour so that an equall hour is the 24th. part of the whole *Equinoctiall circle*.

In the latitude of 49. degrees, the longest day containeth 16 houres; Now therefore when it is 10 of the clock before Noon; or the sixth hour after Sun-rising on this day, I desire to know, what unequall hour of the day it is. I therefore dispose my proportionall terms thus, 16 give 6 therefore 12. (which is the number of equall hours in every day or night) give 4. and an half.

And if we desire to know, how many degrees of the *Æquator* do answer to one unequall hour; we may do it thus: namely by dividing the whole number of degrees of the *Diurnall Arch* by 12. As if the *Artificiall day* bee 16 equall houres in length, then the *Arch* of the *Diurnall Parallel* will be 240 degrees. Which if we divide by 12 the quotient; which is 20 will shew the number of degrees in the *Æquator*, that answer to one unequall hour. The like method also is to be observed; in finding out the length of the unequall hour of the Night

CHAP. XIV.

To find out the Longitude, Latitude, and Declination of any fixed Star, as it is expressed in the Globe.

THe Longitude of a Starre, is an Arch of Eclipticke intercepted betwixt two of the greater Circles, which are drawne thorough the Poles of the Eclipticke, the one of which passeth through the intersection of the Æquator and Ecliptick, and the other through the Center of the star.

The Latitude of a Starre, is the distance of it from the Ecliptick; which is also to be reckoned in that circle which passeth through the Center thereof.

Now if you desire to find out either of these you must take the Quadrant of altitude, or any other Quadrant of a circle, that is but exactly divided into 90 parts: and lay one end of it on either Pole of the Ecliptick, either N. or S. as the Latitude of the Star shall require. Then let it passe through the Center of the Starre to the very Ecliptick, and there the other end will shew the degree of Longitude of the same, which you must reckon from the beginning of Aries: and so that portion of the Quadrant that is contained betwixt the Starre it selfe and the Eclipticke,

ticke, will also shew the Latitude of the Star.

PONT. The manner how to find the longitude and latitude of Starres, may bee shewed by this example. First, let us propose the head of Medusa. which is found in the Tables to bee in the twentie one gr. 8. and it hath in Northerne latitude twentie three degrees. Now therefore in the superficies of the Globe wee must looke for the signe 8. and reckon 21. gr. from the beginning of the same on the Eclipticke: And the circle that shall bee drawn from the Pole of the Ecliptick, through this degree, shall be called the circle of longitude of the head of Medusa. After this, reckon the latitude of the Starre also in the same circle among the Parallels of latitude, beginning from the Eclipticke, and so forward toward the Arcticke Pole, (because the latitude of it is Northerne.) untill you have accounted 23. gr. which is the number of the degrees of latitude, and sheweth the place of that Star.

Now because that all the circles of Longitude, and latitudes neither are, nor indeed can conveniently be expressed on the Globe: therefore the Quadrant of altitude is to serve in stead of the same, for the finding out of the longitudes and situations of the Starres that are set in the Globe: and that after this manner. Let us take our former example of Medusa's head: the latitude of which being Northerne, I apply the end of the Quadrant to the North Pole of the Zodiack: (otherwise, had it been Southern, it must have been fitted to the Southern Pole:) which done, I seeke

in the *Eclipticke* for the 21 gr. of *Taurus*, which is the longitude of the *Starre*; and having found it, I lay the other end of my *Quadrant* over it. For by this means the *Quadrant* shall supply the office of the circle of Longitude of *Medula's* head. Now therefore if I reckon 23. degrees on the said *Quadrant* beginning from the *Eclipticke*, I shall have the true situation of this *Starre* in the *Globe*.

In like manner may we find, by a *Globe* that hath the *Starres* described on it, the longitude and latitude of any *Starre* in the *Heavens*. For if we fit the *Quadrant* to the Northern Pole of the *Zodiack* (if the *Starre* have Northern latitude) and then let it passe through the center of any *Starre*: the degree of the *Ecliptick* that the other end of it shall point out, will be the longitude of the said *Starre*: and the degrees that are contained betwixt the *Ecliptick* and the *Starre*, will shew you the latitude of the same. *A*. for example if the *Quadrant* being first applied to the Northern Pole of the *Zodiack*, bee afterward laid along over the the bright *Star* in the *Crown*; the other end of it will fall on the 6. gr. m. which is the longitude of this *Starre*. And then if you reckon the number of degrees betwixt the *Eclipticke* and the same *Starre*, you shall find them to bee 44 $\frac{1}{2}$. which is the Northern latitude of the same.

The Declination of a *Starre*, is the distance of it from the *Aequator*: which distance must bee reckoned on a greater circle, passing through the Poles of the *Aequator*. And there-

therefore if you but apply any Starre to the Meridian, you shall presently have the Declination of it, if you account the degrees and minutes of the Meridian (if there be any) that are contained betwixt the Center of the Star and the Æquator.

P O I N T. The Declination of Starrs, as also their Right Ascension, may be known by the Globe in this manner. The Star proposed must be applied to the Meridian, and forthwith the same Meridian will discover, among the degrees of the Æquator, the Right Ascension of the same: and it will also give you the Declination, if you reckon upon it the number of degrees that are comprehended betwixt the Equinoctiall and the Star proposed. And for an example of this, let us propose the Great Dog, whose right Ascension and Declination wee desire to know. First, therefore we set the Starre it selfe directly under the Meridian, and find the Meridian to cut the Equinoctiall at 97. gr. 15. min. And this is the right Ascension of this Star. And then reckoning the number of the degrees comprehended betwixt it and the Equinoctiall Southward, we find them to be 16 degrees, which we conclude to bee the Southern latitude of the Starr.

The same also may be demonstrated by the Sun. For when the Sunne is in the 3. gr. of Gemini, he is carried under the Meridian, which crosseth the Equinoctiall about the 63. gr. reckoning from the first degree of Aries in the Æquator. And this is the Ascension of the Sun when he is in the 3. degree of Gemini. Now the number of the

degrees that are comprehended betwixt the place the Sun and the *Æquator*, being reckoned in the *Meridian*, are found to be 21 which is also the Suns Declination, and that Northward, because it falleth among the Northern signs.

The same may be performed also after another manner, as thus for example. The right *Ascension* of the bright Star in the *Crown* is found in the *Astronomicall Tables* to be 275. gr 31. m. and the declination of it Northward 38. gr. 26. minutes. First therefore I reckon the degrees of Right *Ascension* in the *Æquinoctiall*, beginning at the first degree of *Aries*; and having found the degree I apply it to the *Meridian*, in which I afterward reckon the Declination assigned, beginning from *Æquinoctiall*, and proceeding toward the *Arcticke Pole*, if the Declination of the Starre bee Northern; if otherwise, toward the *Antarick*.



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A Table representing the Longi- tude, Latitude, Right Ascension, and decli- nation of some certain Notable STARRES.

The names of the Starrs	Longitude		Latitude		Nor.	Right Ascen- D. M.	Declina.		Nor.
	Deg.	Min.	D.	M.			Dr	M.	
The 1 Starr in the Rams Horn.	Y	28	0	7 20	Nor.	20	0	18	0 Nor.
The 1 horle in the wain	π	3	30	53 30	Nor.	188	10	57 27	Nor.
The 3 horle	π	21	10	54 0	Nor.	202	24	51 5	Nor.
The head of the Dragon.	γ	21	0	75 30	Nor.	226	8	52 8	Nor.
Bootes left shoulder	β	11	0	49 0	Nor.	212	50	40 0	Nor.
Arcturus.	α	18	20	31 30	Nor.	109	17	2: 53	Nor.
The bright Star in the Crown.	μ	6	0	44 30	Nor.	229	0	38 25	Nor.
The head of Hercules.	γ	9	0	37 30	Nor.	252	51	17 36	Nor.
The bright Star of Ly- bra.	ν	8	40	62 0	Nor.	275	31	38 26	Nor.
The taile of the Swan.	κ	0	30	60 0	Nor.	307	30	44 15	Nor.
The Swans bill.	ω	25	50	49 20	Nor.	288	40	27 32	Nor.
Cassiopeia's b east.	α	2	10	46 45	Nor.	4	23	54 56	Nor.
The Goat.	II	16	20	22 30	Nor.	71	58	45 7	Nor.
The right side of Per- seus.	α	25	0	30 0	Nor.	43	0	18 0	Nor.
Medusa's head.	α	21	0	23 0	Nor.	41	0	30 0	Nor.

The names of the Stars	Longitude		Latitude Nor.		Right	Declina.	Nor.
	Deg.	Min.	D.	M.	Ascen. D. M.	Dr M.	
Andromeda's head.	15	40	24	30	Nor.	357	Nor
The Star in the end of Pegasus wing	9	0	34	15	Nor.	358	Nor.
Pegasus Shoulder.	15	0	41	10	Nor.	341	Nor.
The Eagle	5	1	29	10	Nor.	292	Nor.
The head of the Serpent- bearer.	6	10	38	0	Nor.	288	Nor.
The bull's eye	1	5	10	10	Nor.	62	Nor.
Castor	14	40	9	40	Nor.	107	Nor.
Pollux,	18	0	6	15	Nor.	110	Nor.
The Lions Heart	13	50	0	10	Nor.	146	Nor.
Spica Virgi- nis.	18	0	2	0	South	195	South
The South balance of Libra.	0	20	0	40	South	217	South
The heart of the Scorpion	1	34	4	38	South	241	South
The tail of Capricorn.	0	4	20	20	South	219	South
Aquarius Thigh.	3	0	7	30	South	337	South
The Whales Tail.	27	0	20	20	South	5	South
The Whale Nostrils.	9	0	7	45	South	40	South
The Right Shoulder of Orion.	1	20	17	0	South	83	South
The left foot of Orion.	0	30	31	50	South	73	South
The little Dog.	20	30	16	0	South	109	South
The great Dog.	0	0	0	0	South	97	South

CHAP. XV.

To find the variation of the Compasse, for any Latitude of place.

THat the Needle touched with the Loadstone, doth decline in diverse places from the intersection of the Meridian and Horizon, is a thing most certain, and confirmed by daily experience. Neither is this a meer forgery of Mariners, intended by them for a cloake of their own errors: as *P. De Medina*, Grand Pilot to the King of *Spain* was of opinion. Neither yet doth it so come to pass, by reason that the virtue of the Magnet, by long use and exercise is weakened; as *P. Nonius* conceived: or else because it was not originally endued with sufficient vertue: as some others coldly conjecture: but this motion proceeds from its own naturall inclination. The cause of this deflection, although hitherto, in vain sought after by many; hath yet been found by none. In this, as in all other of Natures hidden and abstruse mysteries, wee are quite blind. There have been some that have endeavoured to prescribe some certain Canon, or rule for this Deflection, as if it had been regular and governed by some certain order: but all in vain. For that it is inordinate and irregular, is testified by daily experience, not only such as is taken from the dull conjecture
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of the common sort of Marriners, which oftentimes falls farre wide of the truth : but from the far more accurate observations of skilfull Navigators.

At the Isles, which they call *Azores*, it declineth not at all from the true Meridian : as the common opinion of Marriners is. And I dare bee bold to affirm, that at those more Western Islands also, it varieth very little or nothing at all. But if you saile Eastward from those Islands, you shall observe that point of the Needle that respects the North, to incline somewhat towards the East. At *Antwerpe* in *Brabant* it varieth about nine degrees : and neare *London* it declineth from, the true Meridian above eleven degrees. And if you saile Westward from those Islands, the Needle also will incline toward the West. About the Sea Coasts of *America*, in the Latitude of thirtie five, or thirtie sixe degrees, it declineth above eleven gr. from the true Meridian. Beyond the *Æquatour* it happens clean otherwise. Neare the outwardmost Promontory of *Brasile*, looking Eastward, which is commonly called, *C. Frio*, it varieth from the true Meridian above twelve degrees. Within the most Eastward parts of the Straites of *Magellane* it declineth five or sixe gr. And if you sail from that Promontory, we now spoke of, toward *Africke* Eastward, the variation still encreaseth, as far as to 17, or 18. degrees : which (as farre as

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we can conjecture.) happen in a Meridian not farre from that which passeth through the *Azores*. From thence the deflection decreaseth to nine or tenne gr. which happeneth neare the Isle of *Saint Helen*, bearing somewhat toward the West. And from hence they say it decreaseth, till you are past the *Cape of good hope*, where they will have it to lye in the just situation of the true Meridian, neare to a certain river, which for this cause is called by the *Portugalls*, *Rio de las Aguilas*. And all this deviation is toward the East.

All this wee have had certain prooffe and experience of, and that by as accurate obliervations as those instruments, which are used in Navigation, would afford, and the same examined and caculated according to the doctrine of Sphæricall Triangles. So that we have just cause to suspect the truth of many of these traditions, which are commonly delivered, concerning the deflection of the Needle. And namely whereas they report, that under that Meridian which passeth through the *Azores*, it exactly respects the true Meridian: and that about the Sea coasts of *Brasilia* the North point of the Needle declineth toward the West, (as some affirm) wee have found this to be false. And whereas they report that at New-found land it declineth toward the West above 22 degrees: we very much suspect the truth hereof: because that this seems not at all to agree with the observatiō we have made
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concerning the variation about 11. degrees, near upon the coasts of *America*: of the truth of which I am so confident, as of nothing more. It therefore appears to be an idle fancy of theirs, who look to find some certain point which the Needle should alwayes respect: and that either on the earth, (as namely some certain Magneticall mountains, not far distant from the Arcticke Pole,) or else in the Heavens, as (namely the tail of the little Bear, as *Cardan* thought:) or else that it is situate in that very Meridian that passeth through the *Azores*, and about fixteene degrees and an halfe beyond the North Pole: as *Mercator* would have it. And therefore, there it no need to be taken to them, neither, who conceive that there might be some certain way found out of calculating the longitudes of places by means of this deflection of the Needle: which I could wish they were able to performe: and indeed it might bee done, were there any certaine point that it should alwayes respect.

But to leave this discourse, let us now see, how the quantity of this declination of the Needle may bee found out by the use of the *Globe*, for any place of known latitude, And first you must provide you of some instrument by which you may observe the distance of the Suns *Azimuth* from the situation of a Needle, Our Mariners commonly use a Nautical Compass, which is divided into three hundred sixtie degrees, having a thread placed crossewise

wise over the center of the Instrument to cast the shadows of the Sun upon the center of the same. This Instrument is called by our Mariners, the Compasse of variation: and this seemeth to bee a very convenient Instrument for the same use. But yet I could wish that it were made with some more care and accuratenesse, then commonly it is.

With this, or the like instrument, you must observe the distance of the Suns *Azimuth*, for any time or place, from the projection of the Magnetical Needle. Now we have before shewed, how to find out, how much the verticall circle of the Sun is distant from the Meridian. And the difference that there is betwixt the distance of the Sun from the true Meridian, and from the situation of the Needle, is the variation of the Compasse. Besides, we have already shewed, how the Amplitude of the rising and setting of the Sun may be found. If therefore by the help of this, or the like instrument, it be observed, (as we have said) how many degrees the Sun riseth or setteth from those points in the Compass, that answer to the East or West: you shal in like manner have the deviation of the Needle from the true Meridian, if it have any at all.

PONT. *At the end of this Chapter, I think it not amisse to set down, that which Joseph Delinger, sometime upon occasion offered, wrote unto David Rivaldus, concerning the declination of the Magneticall Needle from the true Meridian. This Epistle of his is extant among those Epistles*

Epistles that were set forth at Paris with some other of his works, Anno 1610. And because that there is something in the same that concerns the controversie of the Precession of the Equinoctiall points; I will set down very near the whole Epistle: and thus it is. Literas tuas cum maxima voluptate &c.

Your Letters I have receeived, and with very great satisfaction and delight: wherein I perceived two things chiefly so bee insisted upon: which were, the Declination of the Magneticall Needle; and the Precession of the Equinoctiall points. In my former Letters I made mention indeed of the same, but with an intention rather to discover the opinion of others, then to proclaim mine own. For I onely made a bare proposall of the matter, and no dogmaticall Position: that so, if the said declination bee to bee examined by the Meridians, add the Meridians, according to my Hypothesis, be moveable; that then our Astronomers and Navigators should see, whether or no, there might not some cause and reason of this so manifest disagreement bee discovered, out of this Essay of mine. For I would not have proposed it onely, had I been certainly assured of it: but would rather have endeavour'd to make it appear by demonstration. Whether therefore, that be the cause of it, which I desire should be searched for out of my Hypothesis; or whether it be some other it shall be all one to me. But the investigation of the Meridians is not sufficient for this matter. For

we

wee must first dispute concerning the nature of the Magnet, whether or no it be the property of it, always to respect the North point: and if so, yet seeing that it declines from the beam proposed, so many degrees, we are next to enquire, whence this Variation proceeds: which certainly can be assigned to no other thing, then to the Meridians. But that wee may not urge this question any farther: we must consult with those Authors that have written of the Magnet; and especially with William Gilbert of Colchester, a Philosopher and Practitioner of Physick in London, who about three yeres since put forth three large bookes of the same subject: wherein hee hath discovered to me his own learning rather, then the nature of the Magnet. For now I am more in doubt, then before. The other part of your Letter is, concerning the Precession of the Equinoctiall points. It was observed first of all by Hypparchus, out of the observations of the fixed Starrs of Aristarchus Saminus, Conon, and Timocharis, that the Equinoctiall points were gone forward into the precedent parts; because that hee had found that the four points (Equinoctiall and Solsticiall) were farther off from the Starrs assigned for the same, then they were in the time of those Astronomers. Which when hee saw, hee doubted not forthwith to affirme, that the Equinoctiall points were immovable, and that the Sphere of the fixed Starrs was gone backe into the succeeding parts. And he did not perswade himselfe onely to this, but even Ptolemy also; and Ptolemy, all that came after him;

so great is the power of Prejudicate Authority. And he also rectified the Globe, and made the taile of the little Bear to be distant from the Pole twelve gr. twenty four min. choosing rather to believe it to be so, then to consult with the Starrs to see whether it were so indeed, or no. Which thing I cannot sufficiently wonder at in him; seeing, that not only in his time, but also two hundred and eighteen yeares before him, the taile of the lesser Bear was no farther from the Pole of the world, then it is at this day: as Eudoxus observed. Which I have most plainly demonstrated in my book of the Præcession of the Equinoctiall point. Besides, Eratosthenes also, who wrote one hundred twenty eight yeares after Eudoxus, affirmed the same of the same Starre: and so did those that wrote in Augustus his time. If therefore two hundred and eighteen yeares before Hipparchus time, that Starre was where it is now; how then can that position of Hipparchus stand, who placed it 12. gr. 24 min. of the Pole of the world? For if the Sphere of the fixed Starres laid more backward into the succeeding parts, (as hee would have it) and that in his time the Taile of the Cynosure was 12. gr. 24. min. distant from the Pole: it necessarily follows, that in Eudoxus time it must have been farther distant from the Pole, by 13. or 14. gr. For this is the proportion of degrees required for that motion. But it was then no farther distant, then it is at this day: and therefore Hipparchus hath abused both himselfe, and all that have come after him. And indeed

indeed I my selfe have made a collection out of him, of all the risings and settings of the Starres; which no man shall ever be able to understand, except he first make such a Globe, wherein the taile of the Cynosure shall be 12. gr. 24. min. distant from the Pole. which thing when I imparted to that great Astronomer Tycho Brahe, he was amused, and wondered very much at the novelty and strangeness of the thing: and indeed not without cause. For I did not speak a word to him of the construction of Hipparchus his Globe, and the distance of the Cynosure from the Pole of it. And therefore we plainly see, that for as much as this Star keeps the same distance from the Pole at this day, that it did 1967. years since, there is no motion at all of the eighth Sphere into the succeeding parts, but of the Æquinoctiall points into the precedent. For of the motion there is no doubt at all to be made, for at this time the Æquinoxe falleth before the first Star in Aries above 28. gr. which notwithstanding in Eudoxus his time happened at the very Star.

But now whether the Star hath left the Sun behind it, or the Sun the Star, is the principall matter in question. For it must be, that one of them must stand still, and the other move: but wee have already shewed, that the Starrs are immovable: and therefore the Sun and Æquinoctiall points are movable. And indeed they have manifestly gone forward since Eudox's time 28. degrees.

This Copernicus (that great Scholar, and second Ptolomy of our age) perceived, when he

spake these words. Vos putatis, &c. You think (saith he) that the eighth Sphere moveth into the consequent parts: but consider whether the Equinoctiall points do not rather move forward. Whence it appears, that this never sufficiently commended man, concluded, that there was a praecession of the Equinoctiall points, and not a motion of the eighth Sphere into the subsequent parts. For one of these being granted, the other must necessarily bee taken away: for if the eighth Sphere doth not move backward, the Equinoctiall points must necessarily move forward. And therefore herein Copernicus conjectured aright. But hee omitted the chiefest matter of all, either because perhaps hee perceived it not, or else despaired of ever being able to demonstrate it. For seeing that the Equinoctiall points are Moveable, it must needs follow, that a greater Circle described by the same must bee Moveable also, by the twenty Sphaeric. Element. And if the Circle bee Moveable, the Pole must also be Moveable. And therefore the Pole of the Equinoctiall is not the same with the Pole of the world: for this is Immoveable, but the other Moveable: for so consequently all the greater Circles passing through these Poles, which are the Meridians, are also Moveable. So that Sunne-Dialls, and all Sciopticall instruments, that are placed upon a Meridian Line, after some certain term of years, must necessarily be defective: because the line it selfe is removed from its former situation. Of which v-riablenesse wee have observed notable

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arguments in monuments of Antiquity. These things, it did concern Copernicus either to have seene, or demonstrated, who was the first man that ever rejected that fabulous and ridiculous motion of the eighth Sphere, and withall proposed this opinion of the Precession of the Equinoctiall points: who, had hee but seen those things, which we have observed historically out of the writings of the Ancient Astronomers, so great was the ingenuity of the man, that he would have instantly consented, and demonstrated the matter Mathematically; which certainly is no hard matter to do. For, is there any man so void of all reason and judgement, as having granted the Equinoctiall points to bee Moveable, to deny that a great Circle described by the same, must necessarily be moveable also: and if so, that the Poles are also Moveable: and again this being granted, that the Meridians are so too? He that shall deny this, I cannot see, what it hath profited him to have studied the Mathematicks.

But you will object, that the Meridians are not changed, because they pass through the Poles of the world, which are Immutable.

But then you have forgotten our Hypothesis, which is, that the Poles of the Equinoctiall are not the same with the Poles of the world. For these are immutable, but those other Mutable. And therefore wee see the necessity of this Argument; and withall, that these things being so, we are yet very
far

farre to seek in many things necessary for the situation and construction of the Sphere. For by this reckoning it followeth necessarily, that the Equinoctiall Circle should not bee described directly Parallel to the Pole of the world: and many other things of this nature, which might hence bee concluded, I might willingly omit, because I speak to a Mathematician, who might better teach in these things. Wherefore I think I may boldly say, that none can be so impudent as to deny these things which are so manifest, as that we can prove them not only Historically, but also Apodictically, by certain demonstrations. And it behoves you to see and examine more narrowly whatsoever hath been written by Mathematicians concerning this matter. For there is now no place left of denyall, but rather to see, how these things may be better demonstrated, and this done, the construction and position of the Sphere corrected. But I do not speak this to the common sort of Astrologers, who never have read any thing but the Theories of the Planets, and never so much as saw any of the ancient Writers: unto whom, although they should perhaps have recourse, they could not understand.

Now as concerning the motion of Trepidation, it is long since exploded: and for Copernicus his motion of Libration, which is also a very vain conceit, and I shall speak more of it hereafter, and shew whence this so idle a dream should possesse so worthy a man: for it differeth not much from that imposture of Trepidation. And as the truth hath at length got place, and removed

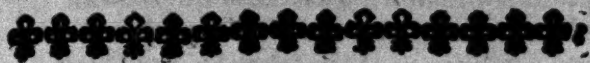
removed that fabulous motion of Trepidation, so we doubt not but necessity will at the last send after it this motion of the eighth Sphere also.

This therefore is the summe of our answer: that we desire, that the skillfull Artists would consider, whether the knowledge of the variation of the Magneticall Needle may be illustrated by those things which we have delivered concerning the Mutability of the Meridians: That there is no motion of the eighth Sphere into the consequent parts: That we are the first that have demonstrated the same: And that from thence must necessarily follow the precession of of the Æquinoctiall points. And this being granted, that then the Æquinoctiall points, Æquinoctial Circles, and their Poles, and Meridians, passing through them are also movable: and their Poles also different from the Poles of the world. And that the situation of Sun Dialls doth vary after some tearme of years: and that we are the first that observed the History of this notable piece of Antiquity; which also may be demonstrated out of the Mathematicks. This is my opinion, which I will ever defend. But do you consider better of it: and in the mean time Farewell, Lug. Bat. 16. Kal. Mai. An. 1604.

And this is Scaliger's Epistle, in which whereas he speaketh of three Books of the Magnet, written by W. Gilbert, it seems to be a slip of his memory: for the same Author wrote not three, but sixe Books de Magnete, which were Printed at London by Peter Short, Anno 1600.

the fourth and fifth books whereof do especially handle the doctrine of the variation of the Compass. And whereas he addeth, that himselfe had plainly demonstrated in a certain book of his, that the Tail of the Cynosure had the same situation anciently, that it hath at this day; he meaneth that book which beareth title, *Platiba de Aequinoctiorum Anticipatione*, and was printed at Paris, Anno 1613. Which Book I understand since, that Johannes Maginus a Paduan, and professor of the Mathematicks in Bononia, hath undertaken to confute: as appears by the Catalogue of Books in the year 1617. where there is mention made of the same confutation printed at Rome, by Andrew Brugloti; and at Colen, by Anthony Hierat, in quarto. In which book the Author takes upon him to impugn certain new Tenets, concerning the Polar Star, and the mutation of the Aequinoctiall points, and immobility of the fixed Starrs: with divers Astronomicall matters, which the title promiseth: notwithstanding it hath not yet been my good hap, though I have made very diligent enquiry, to meet with any of these books.





CHAP. XVI.

How to make a Sun Diall by the Globe, for any Latitude of place.



I do not here promise the whole Art of Dialling: as being a matter too prolix to be handled in this place, and not so properly concerning our present business in hand. And therefore it shall suffice us to have touched lightly, and as it were, pointed out onely some few grounds of this Art: being such as may very easily be understood by the use of the *Globe*.

And here in this place we shal shew you only 2 the most common sorts of Dials: one whereof is called an *Horizontall* Diall, because it is described on a plain or flat, which is Parallel to the Horizon: and the other is called a *Murall*, as being erected, for the most part, on a wall, perpendicular to the Horizon, and looking directly either toward the North, or South. But both these may not unfitly be called *Horizontal*, not in respect of the same place indeed, but of diverse. And therefore whether it be a Flat Horizontall, or Erect, or else inclining any way: there will be but one kind of artifice in making of the same.

Let us therefore now see in what manner a
plain

plain Horizontall Diall may be made for any place. Having therefore first prepared your flat Diall Ground, Parallel to the Horizon, draw a Meridian on it, as exactly North, and South as possibly you can. Which done, draw another East and West, which must cross it at right angles. The first of which lines will shew twelve, and the other six of the Clock, both morning and evening. Then making a Center in the intersection of these two Lines, describe a circle on your Dial Ground, to what distance you please: and then divide it, (as all other circles usually are) into 360. parts. And it will not be amiss to subdivide each of these into lesser parts, if it may conveniently be done. And now it only remains to finde out the distances of the hour lines in this circle, for any latitude of place. Which that we may do by the use of the *Globe*, let it first bee set to the latitude of the place assigned. And then make choice of some of the greater circles in the *Globe*, that pass through the Poles of the world; (as for example, the *Æquinoctiall* Colure, if you please:) and apply the same to the Meridian: in which situation it sheweth midday, or twelve of the Clock. Then turning about the *Globe* toward the West, (if you will) till that fifteen degrees of the *Æquator* have passed through the Meridian: you must mark the degree of the Horizon that the same Colure crosseth in the Horizon. For that point will shew the distance of the first and eleventh hours from the Meridian. Both
of

of which are distant an hours space from the Meridian, or line of midday. Then turning again the *Globe* forward, till other fifteen degrees are past the Meridian: the same Colure wil point out the distance of the tenth hour, which is two hours before Noon, and of the second hour after noon. And in the same manner you may find out the distances of all the rest in the Horizon, allotting to each of them fifteen degrees in the *Aequator* crossing the Meridian. But here you must take notice by the way, that the beginning of this account of the distances, must be taken from that part of the Horizon, on which the Pole is elevated: to wit, from the North part of the Horizon, if the Arcticke Pole be elevate; and so likewise from the South part, if the Antartick be elevated.

These distances of the hours being thus noted in the Horizon of the *Globe*, you must afterward translate them into your Plain, allotted for your Diall Ground, reckoning in the circumference of it so many degrees to each hour, as are answerable to those, pointed out by the Colure in the Horizon.

And lastly, having thus done, the Gnomon or Stile must be erected. Where you are to observe this one thing (which is indeed in a manner the chiefe and onely thing in this Art to be carefully looked unto) namely, that that edge or line of the Gnomon, which is to shew the hours by its shadow, in

in all kinds of Dials must be set Parallel to the Axis of the world: that so it may make an Angle of Inclination with its plain ground, equal so that which the Axis of the world makes with the Horizon. Now that the Stile is to stand directly to the North and South, or in the Meridian line, is a thing so commonly known, that it were to no purpose to mention it. And this is the manner of making a Diall on a plain Horizontall Ground,

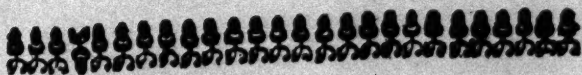
Now if you would make a plain Erect Diall perpendicular to the Horizon (which is commonly called a *Murall*) and respecting either the North or South : you must remember this one thing : (the ignorance whereof hath driven those that commonly professe the Art of Dialling into many troubles and difficulties :) this one thing, I say, is to be observed: that that which is an erect Diall in one place, will be an Horizontall in another place, whose Zenith is distant from that place 90. degrees, either Northward or Southward.

As for example : Let there be an Erect Diall made for any place whose latitude is 25. gr. this is nothing else, but to make an Horizontall Diall for the latitude of 38 degrees. And if there be an Erect Diall made for the latitude of 27. gr. the same will be an Horizontal Diall for the latitude of 63 degrees. The same proportion is to be observed in the rest. And hence it manifestly appears, that an Horizontal Diall and a Verticall are the same, at the latitudes of 45 degrees.

And

And so likewise by this rule may bee made any manner of inclining Diall, it so be, that the quantity of the inclination be but known. As for example, if a Diall be to be made on a plain ground, whose inclination is 10. degrees from the Horizon Southward, and for a place whose latitude is 52. gr. Northward: you must describe in that plain Horizontall Diall for the Latitude of 62. degrees Northward. And if in the same latitude the Diall ground do incline toward the North 16. gr. you must make an Horizontall Diall for the Northern latitude of 36. gr:

And thus much shall suffice to have been spoken of the making of Dialls by the *Globe*.



The



Calculus and Algebra

The first part of the book is devoted to the study of the properties of the real numbers. It begins with a discussion of the natural numbers, and then proceeds to the integers, the rational numbers, and finally the real numbers. The second part of the book is devoted to the study of the properties of the real numbers. It begins with a discussion of the properties of the real numbers, and then proceeds to the study of the properties of the real numbers. The third part of the book is devoted to the study of the properties of the real numbers. It begins with a discussion of the properties of the real numbers, and then proceeds to the study of the properties of the real numbers.

Calculus and Algebra

Calculus and Algebra

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The fifth and last Part,

Of the Rumbes that are described in the Terrestriall Globe, and their use.



Hose lines which a Ship, following the direction of the Magneticall Needle, describeth on the surface of the Sea, *Petrus Nonius* calleth in Latine, *Rumbos*, borrowing the Apellation of his Countrymen the *Portugals*. Which word, since it is now generally received by learned writers to express them by : we also will use the same.

These *Rumbes* are described in the *Globe*, either by greater or lesser circles, or by certain crooked winding liines. But Sea-men are wont to express the same in their Nauticall Charts by rights Lines. But this practise of theirs is clean repugnant to the truth of the thing, neither can by any means be defended from errors. The invention of *Rumbes*, and practise of describing the same upon the *Globe*, is somewhat ancient. *Petrus Nonius* hath written much concerning the use of them, in two Books which he intituleth, *de Navigandi ratione*. And *Mercator* hath also expressed

pressed them in his *Globes*. But the use of them is not, as yet, so well known to every body: and therefore I think it not unfit, to be the more large in the explication of the same.

Beginning therefore with the nature and originall of them, we shall afterward descend to the use, there is to be made of them in the Art of Navigation. And first, we will begin with the originall, and nature of the Nauticall Index, or Compasse; which is very well known to be of the fashion of a plain round Box, the Circumference whereof is divided into 32. equall parts, distinguished by certain right lines passing through the center thereof. One point of it, which that end of the needle that is touched with the Magnet, always respects, is directed toward the North; so that consequently the opposite point must necessarily respect the South. And so likewise all the other parts in it have respect unto some certain fixed points in the Horizon: (for the Compasse must always be placed Parallel to the Horizon.) Now I call these points fixed, onely for doctrine sake, not forgetting, in the mean time that the Magneticall Needle, (besides that it doth of it own nature decline in divers places from the situation of the true Meridian, (which is commonly called the variation of the Compass) according to the custome of divers Countries, is also placed after a divers manner in the Compass. For some there are that place it 5. gr. 37. m. more Eastward then that point that answereth to the North quarter

of the world: as do the *Spaniards*, and our *Englishmen*. Some place it 3. gr. and almost 18. m. declining from the North: and some set it at 11. gr. 15. minutes distance from that point. all which notwithstanding, let us suppose the Needle always to look directly North and South. Now these lines thus expressed in the Mariners Compass, as the common intersections of the Horizon, and Verticall Circles, or rather Parallel to these. Among which, that wherein the Needle is situate, is the common intersection of the Horizon & Meridian. And that which crosseth this at right Angles, is the common section of the Horizon, and a verticall circle drawn through the Equinoctiall East and West. And thus we have the 4. Cardinall winds or quarters of the World, and the whole Horizon divided into 4 equal parts, each of them containing 90. degrees. Now if you divide again each of these into 8. parts, by 7. verticall circles, drawn on each side of the Meridian, through the Zenith: the whole Horizon will be parted into 32 equal sections: each of which shall contain 11. gr. 15. m. These are the severall quarters of the world observed by Mariners in their voyages: but as for any lesser parts or divisions then these, they look not after them. And this is the original of the Nautical Compass, by which Sea-men are guided in their voyages.

Let us now in the next place consider, what manner of lines a Ship, following the direction of the Compass, doth describe in her course

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For the better understanding whereof, I think it fit to promise these few Propositions: which being rightly and thoroughly considered, will make the whole business facile and perspicuous.

1. All Meridians of all places do pass through both the Poles: and therefore they cross the Æquator, and all Circles Parallel to it, at right angles.

2. If wee direct our course any other way then toward one of the Poles: wee change ever and anon both our Horizon and Meridian.

3. The needle being touched with the Loadstone, pointeth out the common Interfection of the Horizon and Meridian: and one end of it always respecteth the North, in a manner, and the other, the South. And here I cannot but take notice of a great error of *Gemma Frisius*, who in his Corollary to the fifteenth Chapter of *P. Appians* Cosmography, affirms, that the Magnetical Needle respects the North Pole on this side of the Æquinoctiall line, but on the other side of the Æquinoctiall, it pointeth to the South Pole. Which opinion of his is contradicted, by the experience both of my selfe and others. And therefore, I believe, his too much credulity deceived him, giving credit perhaps to the fabulous relations of some vain heads. But howsoever it be, the error is a lowle one, and unworthy so great an Author. This frivolous conceit hath also been justly condemned before, by the Illustrious

Jal.

Jul. Scaliger, instructed hereto out of the Navigations of *Ludovicus Vertomannus*, and *Ferdinand Magellane*.

4 The same *Rumbe* cutteth all the Meridians of all places at equall Angles, and respecteth the same quarters of the world in every Horizon.

5 A greater Circle drawn through the vertex of any place, that is any whit distant from the *Æquator*, cannot cut divers Meridians at equall Angles. And therefore I cannot assent to *Pet. Nonius*, who would have the *Rumbes* to consist of portions of greater Circles. For seeing that the portion of a greater Circle, being intercepted betwixt divers Meridians, though never so little distant from each other, maketh unequall Angles with the same, a *Rumbe* cannot consist of them, by the precedent proposition. but this inequality of Angles is not perceived (saith he) by the sense; unless it be in Meridians somewhat far remote from one another. Be it so. Notwithstanding the error of this Position is discoverable by Art and demonstration. Neither doth it become so great a Mathematician, to examine rules of Art by the judgement of the sense.

6 A greater Circle drawn through the Verticall point of any place, and inclining to the Meridian, maketh greater Angles with all other Meridians, then it doth, with that from whence it was first drawn. It therefore behooveth, that a line, which maketh equall

angles, with divers Meridians, (as the *Rumbes* do) be bowed and turn in, toward the Meridian. And hence it is, that when a Ship saileth according to one and the same *Rumbe*, (except it be one of the four Principal and Cardinal *Rumbes*) it maketh a crooked Spiral Line, such as we see expressed in the Terrestrial Globe.

7 The portions of the same *Rumbe*, intercepted betwixt any two Parallels, whose difference of Latitude is the same, are also equal to each other. Therefore an equall segment of the same *Rumbe*, equally changeth the difference of Latitude in all places. And therefore that common rule of Sea-men is true: that in an equall space passed in one & the same *Rumb* one of the Poles is equally elevated, and the other depressed, So that *Michael Coignet* is found to be in an error, who out of some certain ill grounded positions indeavoured to prove the contrary.

Out of the 4 Proposition there arise h this Confectary; namely, That *Rumbes*, though continued never so far, do not pass through the Poles. For seeing that the same *Rumbe* is equally inclined to all Meridians; and all Meridians do pass through the Poles: it would then follow, that if a *Rumbe* should pass through the Poles, the same line in the same point would cross infinite other lines: which is impossible, because that a part of any Angle, cannot be equall to the whole. Neither doth that, which we delivered in the last Proposition make any thing against this Confectary:

to wit, that betwixt any two Parallels of equall distance, equall portions of the same *Rumbe* may be intercepted; that so it should thence follow, that the segment of any *Rumbe* intercepted betwixt the Parallel of 80. gr. of Latitude and the Pole, is equall to a segment of the same *Rumbe* intercepted betwixt the *Æquator* and the Parallel of ten gr. of Latitude: and the reason is, because the Pole is no Parallel. And therefore it was a true Position of *Nonius*, That the *Rumbes* do not enter the Poles: although it was not demonstrated with the like happy successe. For he assumes foundations contrary to the truth: as wee said before. And *Gemma Frisius* also was mistaken, when hee affirmed, in his *Appedix ad 13. Cap. Appian Cosmography.* that the *Rumbes* do concur in the Poles: which was the opinion also of some others who are therefore justly taxed by *Michael Coignet.*

These things being well considered, it will be easie to understand, what manner of lines a Ship, following the direction of the Magnet, doth describe in the Sea. If the forepart of the Ship, be directed toward the North or South, which are the quarters that the Magneticall Needle always pointeth at: your course will bee alwayes under the same Meridian: because, as wee shewed in our third Proposition, the Needle always respecteth the Intersections of the Horizon and Meridian, and is situate in the plain of the

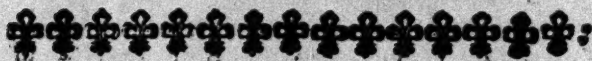
same Meridian. If the fore part of the Ship be directed to that quarter that East and West *Rumbe* pointeth out: in your course you will then describe either the *Æquator*, or a Circle Parallel to it. For if at the beginning of your setting forth, your Zenith be under the *Æquator*, your Ship will describe an Arch or segment of the *Æquator*. But if your Verticall point be distant from the *Æquator* either Northward or Southward; your course will then describe a Parallel, as far distant from the *Æquator*, as the Latitude of the place is whence you set forward at first. As suppose our intended course to be from some place lying under the *Æquator*, by the *Rumbe* of the East and West: we shall go forward still under the *Æquator*. For by this means, as we go on, we always meet with a new Meridian; which the Line of our course crosseth at right Angles. Now no other Line, besides the *Æquator*, can do this: as appears manifestly out of the Corollary of the first proposition. And therefore in this course our Ship must describe a portion of the *Æquator*. But if we steer our course, by the East and West *Rumbe*, from any place that lyeth besides the *Æquator*: we shall be always under the same Parallel. For all Circles Parallel to the *Æquator*, do cut all the Meridians at right Angles, by the Corollary of the first Proposition. And although the fore part of the Ship always respecteth the *Æquinoctiall East* or *West*, or intersection of the *Æquator* and *Horizon*; yet

yet in our progress we shall never come near the Equator, but shall keep always an equall distance from it. Neither shall we come at all thither, whither the fore part of our ship looketh, but shall keep such a course, wherein we shall have, ever and anon, a new Meridian arising, which we shall cross at equall Angles, & so necessarily describe a Parallel. But if our voyage be to be made under the *Rumbe* which inclineth to the Meridian: our course will then be neither in a greater nor lesser Circle, but we shall describe a kind of crooked spirall Line. For if you draw any greater Circle through the Vertex of any place, inclining to the Meridian, the same Circle will cross the next Meridian, at a greater Angle, then it did the former: by the sixth proposition. And therefore it cannot make any *Rumbe*: because the same *Rumbe* cutteth all Meridians at equall Angles, by the fourth proposition. And all the Parallels, or lesser Circles, do cross the Meridians at right Angles, by the Corollary of the first proposition: and therefore they do not incline to the Meridian.

Concerning those lines which are made in Sea voyages by the direction of the Compasse and Magneticall Needle; *Gemma Frisius* in his appendix to the fifteen Chapter of *Appians Cosmography*, part first, speaks thus. *Verbum hoc obiter annotandum, &c.* And (saith he) I think it not amiss to note this by the way, that the voyages on land do differ very much from those that are performed at Sea. For those are

understood to be performed by the greater circles of the Sphære, as it is rightly demonstrated by *Wernerus*, in his *Commenearies* upon *Ptolomy* But the voyager by Sea, are for the most part crooked: because they are seldome taken in a great circle, but sometimes under one of the Parallels; when the Ship steers her course toward East or West: and sometime also in a greater circle: as when it saileth from North to South, or contrariwise; or else under the *Æquator*, either direct East or West. But in all other kinds of Navigation, the journeys are Crooked, although guided by the Magnet, and are neither like to greater circles, nor yet to Parallels: nor indeed are circles at all, but only a kind of crooked lines, all of them at length concurring in one of the Poles. Thus he, and indeed very rightly in all the rest, save onely that he wil have these lines to meet in the Pole: which as we have already proved, is altogether repugnant to the nature of *Rumbes*.

Hitherto have we spoken of the original and nature of *Rumbes*: let us now see what use there is of them in the Terrestriall Globe.





Of the use of Rumbes in the Terrestriall Globe.

IN the Art of Navigation, which teacheth the way and manner how a Ship is to be directed in sailing from one place to another, there are four things especially to be considered. And these are the Longitudes of the places, the Latitudes; or differences of the same *Rumbe*, and the space or distance betwixt any two places, measured according to the practise used in Sea-voyages. For the distances of the places are measured by the Geographer one way, and by the Mariner another. For the former measureth the distances of places always by greater circles; as after *Wernerus*, *Peucerus* hath also demonstrated in his book, *De Dimensione Terra*. But the Mariners course being made up sometimes of portions of greater circles; and sometimes of lesser, but for the most part of crooked lines: it is good reason that he should measure the distances also of places by the same. Which, and how many of these are to be known before hand, that the rest may be found out, come in the next place to be considered. Now the places betwixt which our voyage is to be performed, do differ either in Longitude only, or in Latitude only, or in both.

If they differ only in Latitude, they are both under the same Meridian: and therefore it is the

the North or South *Rumbe*, that the course is to be directed by. And there only then remaineth to know the difference of Latitude, and distance betwixt these two places: One of which being known, the other is easily found out. For if the difference of Latitude be given in degrees and minutes; as Sea-men are wont to do, the number of degrees and minutes, being multiplyed by 60. (which is the number of English miles that we commonly allow to a degree, and that according to *Ptolomies* opinion, as we have already demonstrated:) the whole number of miles, made in the voyage betwixt these places, will appear. And if you multiply the same number of degrees by seventeen and a halfe, you have the same distance in Spanish leagues. And so contrariwise, if the distance in miles or leagues be known, and you divide the same by 60 or seventeen and an halfe, the quotient will shew the number of degrees and minutes, that answer to the difference of Latitude betwixt the two places assigned. As for example. If a man were to sail from the *Lizard* (which is the outmost point of land in *Corn-wall*) Southward, till he come to the promontory of *Spain*, which is called *C. Ortegal*; the difference of Latitude of which places is 60 gr. 10. min. If you desire to know the distance of miles betwixt these places, multiply six gr. ten m. by 60. and the product will be 370. the number of English miles betwixt the two places assigned. And this account may be much more truly and readily

dily made by our English miles, in as much as 60. of them are equivalent to a degree, so that one mile answereth to one minute: by which means, all tedious and prolix computation by fractions is avoyded.

In the next place, let us consider those places that differ only in Longitude: which if they lye directly under the *Æquinoctiall*, the distance betwixt them being known, the difference of Longitude will also be found: or contrariwise, by multiplication or division, in like manner as the difference of Latitude is found. But if they be situate without the *Æquator*; wee must then go another way to work. For seeing that the *Parallels* are all of them lesse then the *Æquator*, all of them decreasing in quantity proportionably, till you come to the Pole, where they are least of all: hence it comes to pass, that there can be no one certain determinate measure assigned to all the *Parallels*. And therefore the common sort of Mariners do greatly erre, in attributing to each degree of every *Parallel*, and equall measure with a degree of the *Æquator*. By which means, there have been very many errors committed in Navigation, and many whole Countries also removed out of their own proper situation, and translated into the places of others.

That therefore there might be provision made in this behalfe, for those that are not so well acquainted with the *Mathematicks*: I have added a Table, which sheweth, what proportion

portion a degree in every Parallel beareth to a degree in the *Æquator*: whence the proper measure of every Parallel may be found. In which Table the first Collume propoeth the severall Parallels, each of them differing from other one degree of Latitude. The second sheweth the minutes and seconds of the *Æquator*, that answer to a degree in each Parallel: which if you convert into two miles, you shall know how many miles answer to a degree in every Parallel.

M. S. M. S. M. S. M. S. M. S.

1	59 59	27	53 27	50	38 34	71	19 31	90	0 0
2	59 57	28	53 58	51	37 46	72	18 51		
3	59 55	29	52 28	52	36 56	73	17 31		
4	59 51	30	51 57	53	35 6	74	16 31		
5	59 46	31	51 25	54	35 16	75	15 30		
6	59 40	32	50 52	55	34 24	76	14 28		
7	59 35	33	50 18	56	33 31	77	13 26		
8	59 29	34	49 44	57	32 40	78	12 24		
9	59 15	35	49 8	58	31 47	79	11 22		
10	59 5	36	48 32	59	30 53	80	10 20		
11	58 53	37	47 55	60	29 59	81	9 18		
12	58 41	38	47 17	61	9 5	82	8 16		
13	58 27	39	46 38	62	8 10	83	7 14		
14	58 15	40	45 58	63	27 14	84	6 12		
15	57 57	41	45 17	64	26 18	85	5 10		
16	57 40	42	44 35	65	25 22	86	4 8		
17	57 22	43	43 52	66	24 24	87	3 6		
18	57 3	44	43 8	67	23 26	88	2 4		
19	56 43	45	42 24	68	22 28	89	1 2		
20	56 20	46	41 40	69	21 30				
21	56 0	47	40 55	70	20 31				
22	55 37	48	0 9						
23	55 13	49	39 22						
24	54 48								
25	54 22								
26	53 55								

By

By the use of this Table, if a Ship have sailed under any Parallel, and the space bee known how far this Ship hath gone, the difference of Longitude may be found by the rule of proportion: and to contrarywise, if the difference of Longitude be given, the distance will in like manner be known. As for example. Suppose a Ship to have set forth from *C. Dalguer*, (which is a Promontory on the West part of *Africk*) and sailed Westward, 200. English Leagues, that is to say, 600 mile. We desire now to know the difference of Longitude betwixt these two places. That promontory hath in Northern Latitude 30. degrees. Now to one degree in that Parallel answer. 51. *m.* 57. *sec.* that is to say, 51 miles, and fifty seven sixtieth parts of a mile. Thus therefore we dispose our proportionall tearms, for the finding of the difference of Longitude. 51. miles, 57. *min.* (or suppose 52. full miles, because the difference is so small) give one degree: therefore 600. give 11 $\frac{1}{2}$ *gr.* which is the difference of Longitude betwixt the place whence the Ship set forth, and that where it arived But the tearms are to be inverted, if the difference of Longitude be given, and the distance be to be sought. But this is not so congruous. For we never use by the known Longitude to seek the distance: but the contrary. Neither indeed have we as yet any certain way of observing the difference of Longitudes: however some great boasters make us large promises of the same. But,

Expectata

Exspectata seges vanis deludet avenis.

It remaineth now to speak of those places that differ both in Longitude and Latitude: wherein there is great variety, and many kinds of differences. Of all which there are four (as we have already said) especially to be considered: and these are the differences of Longitude, and of Latitude, & the distance, & *Rumbe*, by which the voyage is performed. Two of which being known, the rest may readily be found out. Now the transmutation of the things to be granted for known; and to be enquired after in these four terms, may be proposed six manner of ways, as followeth,

The difference of $\left\{ \begin{array}{l} \text{Longitude} \\ \text{and} \\ \text{Latitude} \end{array} \right\}$ being known: $\left\{ \begin{array}{l} \text{Rumbe} \\ \text{and} \\ \text{Distance} \end{array} \right\}$ may also be found.

The difference of $\left\{ \begin{array}{l} \text{Longitude} \\ \text{and the} \\ \text{Rumbe} \end{array} \right\}$ being known: $\left\{ \begin{array}{l} \text{Difference of Latitude} \\ \text{and} \\ \text{Distance} \end{array} \right\}$ may be found.

The difference of $\left\{ \begin{array}{l} \text{Longitude} \\ \text{and} \\ \text{Distance} \end{array} \right\}$ being known: $\left\{ \begin{array}{l} \text{Difference of Latitude} \\ \text{and} \\ \text{Rumbe} \end{array} \right\}$ may be found.

The difference of $\left\{ \begin{array}{l} \text{Latitude} \\ \text{and} \\ \text{Rumbe} \end{array} \right\}$ being known: $\left\{ \begin{array}{l} \text{Difference of Longitude} \\ \text{and} \\ \text{Distance} \end{array} \right\}$ may be found.

The difference of $\left\{ \begin{array}{l} \text{Latitude} \\ \text{and} \\ \text{Distance} \end{array} \right\}$ being known: $\left\{ \begin{array}{l} \text{Rumbe \& Difference} \\ \text{of Longitude} \\ \text{and} \\ \text{Latitude} \end{array} \right\}$ may be found.

The $\left\{ \begin{array}{l} \text{Rumbe} \\ \text{and} \\ \text{Distance} \end{array} \right\}$ being known: $\left\{ \begin{array}{l} \text{Longitude} \\ \text{and} \\ \text{Latitude} \end{array} \right\}$ may be found.

Thus

Thus you see that any two of these being known, the other two may also be found out. Now most of these (yea all of them, that are of any use at all) may be performed by the Globe. And let it suffice to have here given this generall advertisement once for all.

Now besides these things here already to be known: it is also necessary that we know the Latitude of the place whence we set forth, and the quarter of the world that our course is directed unto: for otherwise we shall never be able rightly to satisfie these demands. And the reason is, because that the difference of Longitude and Latitude always wont to be reckoned unto the two parts of the world: some of them to the North and South, and the rest to the East and West. And especially, because that from all parts of the Meridian, and from each side thereof, there are *Rumbes* drawn that are all of equall angles or inclinacions. So that unless the quarter of the world be known, whereto our course tendeth, there can be no certainty at all in our conclusions. As if the difference of Latitude be to be enquired after: the same may indeed be found out; but yet we cannot determine, to which quarter of the world it is to be reckoned, whether North or South. And if we seek for the difference of Longitude: this may be found: but in the mean time we shall not know, whether it be to be reckoned towards the East or West. And so likewise when the *Rumbe* is sought for, we may perhaps find what declination

nation it hath to this Meridian; but yet we cannot give it its true denomination, except we know toward what quarter of the world one place is distant from the other. For from each particular part of the Meridian, the *Rumbs* have equal inclinations. These grounds being thus laid, let us now proceed to the examination of each particular.



I. *The difference of Longitude and Latitude of two places being known, how to find out the Rumb and Distance of the same.*

TURN about the Globe untill that some *Rumb* or other do cross the Meridian, at the Latitude of the place whence you set forth. Then again turn about either toward the East or West, as the matter shall require, untill that an equal number of degrees in the *Equator* to the difference of Longitude of the two places do pass the Meridian. Then afterward look whether or no the aforesaid *Rumb* do cross the Meridian at the Latitude of the place, where you are: for if it do so, you may then conclude, that it is the *Rumb* you have gone by: but if otherwise, you must take another, and try it in like manner, till you light upon one that will do it.

As

As for example. *Serra Liona* is a Promontory of *Africk*, having in Latitude 15. gr. 20. m. and in Northern Latitude 7. gr. 30. m. suppose that we are to sail to the Isle of Saint *Helens*, which hath in Longitude 24 gr. 30 and in Southern Latitude 15. gr. 30. m. I now demand what *Rumbe* we are to sail by: and this we find in this manner. I first apply to the Meridian the 356 gr. 40 m. of Longitude: and withal observe what *Rumbe* the Meridian doth cross at the Latitude Northern of 7 gr. 30. m. (which is the Latitude of the place whence we are to set forth:) and I find it to be the North norwest, and South southeast *Rumbe*. Then I turn about the Globe toward the West, (because Saint *Helens* is more Eastward then *Serra Liona*) untill that 9 gr. 10. m. in the *Æquator* (which is the difference of Longitude betwixt these two places) do cross the Meridian. And in this position of the Globe, I find that the same *Rumbe* is crossed by the Meridian in the Southern Latitude of 15. gr. 30. m. which is the Latitude of Saint *Helens* Isle. Therefore I conclude, that this is the *Rumbe* that we are to go by, from *Serra Liona* to Saint *Helens*. And in this manner you may find the *Rumbe* betwixt any two places, either expressed in the Globe, or otherwise: so that the difference of Longitude and Latitude be but known.

If the places be expressed in the Globe, betwixt which you seek the *Rumbe*; you must then with your Compasses take the distance
V
betwixt

betwixt the two places assigned, and apply the same to any *Rumbe* that you please (but only in those places where they cross the parallels of Latitude of the said places,) till you find a *Rumbe*, whose portion intercepted betwixt the Parallels of the two places, shall agree to the distance intercepted by the Compasses. As for example. If you would know what a *Rumbe* leadeth us from *C. Cantin*, a Promontory in the West part of *Africk*, having in Latitude 32. gr. 20. m. to the *Canary Islands*, which are in the 28. gr. of Latitude. First, you must apply the distance intercepted betwixt the two places to any *Rumbe*, that lyeth betwixt the 28 and 32. gr. 30. m. of Latitude, which are the Latitudes of the places assigned: and you shall find that this distance being applyed to the South South-west *Rumbe*, so that one foot of the Compasses be set in the latitude of 32 gr. 20. m. the other will fall on the 28 gr. of Latitude in the same *Rumbe*. Whence you may conclude, that you must sail from *C. Cantin* to the *Canary Islands* by the South South-west *Rumbe*. There are some that affirm, that if this distance intercepted betwixt two places, be applyed to any *Rumbe* where they all meet together at the *Æquator*, the same may be performed. But these men have delivered unto us their own errours, in stead of certain rules. For suppose it be granted, that the portions of the same *Rumbe* intercepted betwixt two Parallels equidistant from each other, are also equal in any part of the *Globe*; yet notwithstanding

standing they are not to be measured by such a manner of extension. For the *Rumbes* that lye near the *Æquator*, differ but little from greater circles: but as they are farther distant from it, so they are still more crooked, and inclining to the Meridian.

The *Rumbe* being found, we are next to seek the distance betwixt the two places. *Nomus* teacheth a way to do this; in any *Rumbe*, by taking with your Compasses the space of 10 leagues, or halfe a degree. Others take 20 leagues, or an whole degree. But I approve of neither of these, nor yet reject either. Only I give this advertisement by the way: that according to the greater or less distance of the place from the *Æquator*, a greater or less measure may be taken. For near the *Æquator*, where (as we have said) the *Rumbes* are little different from greater circles; you may take a greater measure to go by. But when you are far from the *Æquator*, you must then take as small a distance as you can: because that here the *Rumbes* are very crooked. And yet the distance of places may be much more accurately measured, so that the *Rumbe* and difference of Latitude of the same be but known) by this Table here set down: which is thus.

A Treatise of the

In the	Rumbe	Degr.	Min.	Sec.	Answer to a degree in the Equator, or Meridian.
	First	1	1	10	
	Second	1	4	56	
	Third	1	12	9	
	Fourth	1	24	51	
	Fifth	1	47	59	
	Sixth	2	36	47	
	Seventh	5	7	33	

In this Table you have here let down how many degrees, minutes, and seconds in every *Rumbe*, do answer to a degree in the Meridian or Equinoctiall. Now a degree (as we have often said,) containeth 60 Miles: so that each Mile answereth to a minute, and the sixtieth part of a mile, or seventeen paces, to every second. So that by the help of this Table, and the rule of proportion, the distance of any two places in any *Rumbe* assigned (if so be that their Latitudes be known) may easily be measured: and so on the contrary, if the distance be known, the difference of Latitude may be found. As for example, If a Ship have sailed from *C. Verde* in *Africk*, lying in the 14 gr. 30. m. of Northern latitude, to *C. Saint Augustine* in *Brasile*, having in Southern Latitude 8. gr. 30 m. by the *Rumbe* of South-west and by South: and if it be demanded what is the distance or space betwixt these two places. For the finding of this, we dispose our terms of proportion after this manner. 1. gr. of Latitude in this *Rumbe*, (which is the third from the Meridian)

dian) hath 1. gr. 12. m. 9. sec. that is to say, 72 $\frac{1}{2}$ miles; therefore 23 gr. (which is the difference of Latitude betwixt *C. Verde* and *C. Saint Augustine*) require 1659. miles and almost an halfe, or something more then 553. English leagues, So that this is the distance betwixt *C. Verde* and *C. Saint Augustine*, being measured in the third *Rumbe* from the Meridian.



II. *The Rumbe being known, and difference of Longitude; how to finde the difference of Latitude and distance.*

TO find out this, you must turne the Globe, till you meet with some places, where the said *Rumbe* crosseth the Meridian at the same Latitude that the place is of, where you set forth. And then turning the Globe either Eastward or Westward, as you see cause, untill that so many degrees of the *Æquator* have passed the Meridian, as are answerable to the difference of Longitude betwixt the two places; you must mark what degree in the Meridian the same *Rumbe* cutteth. For that degree sheweth the Latitude of the place, you are arrived.

As for example. The Isle of *Saint Helen* hath in Longitude 24. gr. 20. m. and in Southern

thern Latitude 15. gr 30. m. Suppose therefore a Ship to have sailed West North-west, to some place that lyeth West from it 24 degrees. We demand what is the Latitude of this place. First, therefore we set the Globe in such sort, as that this *Rumbe* may cross the Meridian at the 50. gr. 30. m. of Southern Latitude, which is the Latitude of *Saint Helens*: and this will happen to be so, if you apply the 37. gr. of the Longitude to the Meridian. Then we turn about the Globe Eastward, till that 24 gr. of Equator have passed under the Meridian. And then marking the degree of the Meridian, that the same *Rumbe* crosseth, we find it to be about the 5. gr. 30. m. of Southern Latitude. This therefore we conclude to be the Latitude of the place where we are arived.

And by this means also the distance may easily be found, if the *Rumbe* and difference of Latitude be first known.



III The





II 1. *The difference of Longitude and distance being given; how to finde the Rumb, and difference of Latitude.*

THere is not any thing in all this Art more difficult and hard to be found, then the *Rumb*, out of the distance and difference of Longitude given. Neither can it be done upon the Globe, without long and tedious practise, and many repetitions and mensurations. The practise hereof being therefore so prolix, and requiring so much labour: it is the less necessary, or indeed rather of no use at all. And the reason is, because the difference of Longitude, as we have already shewed, is so hard to be found out. The invention whereof I could wish our great boasters would at length perform: that so wee might expect from them something else, besides bare words, vain promises, and empty hope.

Some of these conclusions also which wee have here set down, are, I confesse, of no great use or necessity, out of the like supposition of the difference of Latitude. Notwithstanding, for as much as the practise of them is easie and facile, I have willingly taken the pains, for exercise sake onely, to propose them.



IV *The difference of Latitude and Rumbe being given, how to finde the difference of Longitude and distance.*

First set your Globe so, as that the *Rumbe* assigned may cross the Meridian at the same Latitude that the place is of, whence you set forth. And then turn about the Globe toward the East or west, as need shall require, till that the same *Rumbe* shall cross the Meridian at the equal Latitude of that place whither you have come. And so marking both places, reckon the number of degrees in the *Aequator*, intercepted betwixt both their Meridians. And this shall be the difference of Longitude betwixt the same places. As for example. *C. D'alguer* in *Africk* hath about 30 gr. of Northern Latitude. From whence suppose a Ship to have sailed North-west and by West, to the thirtie eight gr. of Northern Latitude alio. Now we demand, what is the difference of Longitude betwixt these

these two places? Turning therefore the Globe till the Meridian cross the said *Rumbe* at the thirtieth *gr.* of Northern Latitude, (which will be, when the seventh *gr.* of Longitude toucheth the Meridian,) I turn it again toward the East, untill such time as the Meridian crosseth the same *Rumbe* in the thirty eight *gr.* of Northern latitude: which will happen, when the three hundred fifty second *gr.* of Longitude cometh to the Meridian. Whence we conclude, that the place where the Ship is arived, is Westward from *C. D'alguer* about fifteen degrees. And the Meridian of that place passeth through the Eastern part of Saint *Michael's* Island, one of the *Azores*. Now, how the distance may be found, the *Rumbe* and difference of Latitude being known, hath been declared already in the first proposition.

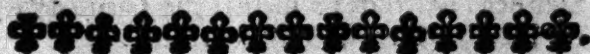


V. *The difference of Latitude, and distance being given, the Rumbe and difference of Longitude may be found.*

THe *Rumbe* may easily bee found out, by the Table which wee have before set down. But an example will make the matter more clear. If a Ship have sailed from the most Western point of *Africk*, commonly called *C. Blanco*, (which lyeth in the 10. gr. 30. m. of Northern Latitude) betwixt North and West, for the space of 1080. miles, and to the 20. gr. 30. m. of Northern Latitude also: and it be demanded, by what *Rumbe* this course was directed: for answer hereof, we proceed thus. The difference of Latitude is 10. gr. and the distance betwixt these places 1080. miles. We therefore dispose our terms thus, 10. gr. contain 1080. miles: therefore 1. gr. containeth 108. miles. Which if we divide by 60. wee shall find in the quotient 1. gr. 48. m. which number if you seek in the Table, you shall finde it answering the fifth *Rumbe*. Neither is the difference betwixt that number in the Table, and this here of ours above one second scruple. So that we may safely pronounce, that this voyage was performed by the fifth *Rumbe* from the Meridian, which is North-west and by west.

Now

Now the *Rumbe* being found, and the difference of Latitude known, you may finde out the difference of Longitude by the second proposition.



VL. *The Rumbe and distance being given, the difference of Longitude and Latitude may also be found.*

THis also may easily be performed, by the help of the former Table. And therefore we will onely shew an example how it is to be done. From the *Cape of good Hope*, which is the most Southernly point of *Africa*, and hath in Southern Latitude about 35 degrees, a Ship is supposed to have sailed North, North-west, (which is the second *Rumbe* from the Meridian) above 642. miles, or If you will, let it be full 650. Now we demand the difference of Latitude betwixt these two places: and this is found ster this manner. First, we take the degree and minutes that answer to a degree of Latitude in the second *Rumbe*, and turn them into miles. And then we finde the number of these to be 64 miles, 56 minutes, for which let us take full 65 miles. Now therefore our rearmes are thus to be disposed: 65. miles answer to 1. degree of Latitude: therefore 650. will be equivalent to ten degrees of Latitude. Which

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Which if you subtract from 34. which is the Latitude of the place, whence the Ship set forth) because the course tends toward the Equator : the remainder will be 25. gr. of Southern Latitude : which is the Latitude of the place, where the Ship is arrived.

Now the *Rumbe* being known, and the difference of Latitude also found ; the difference of Longitude must be found out by the second proposition,



FINIS.





Imprimatur.

Tho. Wykes R. P. Epis.

Lond. Capel. Domest.

Maui. 11^o 1638.

